International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

Remote Control of Home Appliances with Smart Energy Efficient Model Using Android Application Based on Raspberry Pi Embedded Linux Board

Vishal K Upadhye, Prof Satish M Turkane.

Student, Department of Electronics and Telecommunication Engineering, PRECOE, Loni, Maharastra, India.
Professor, Department of Electronics and Telecommunication Engineering, PRECOE, Loni,Maharastra, India.

Abstract - *Smart phones and digitization are gathering attraction and one would like to control hi-tech appliances in home using this technology. It has almost become a requirement to control home appliances from remote location using smart technology. To make this possible a machine or a secondary brain is required to 'Think' and take actions control home appliances to do tasks as per the convenience of the user from long distances. A system is proposed for the users to control home electronic appliances with highly mobile platform and security. A set of devices will be controlled by internet with the help of Raspberry pi micro-controller [1]. A Raspberry pi micro-controller board accepts the user input from an android mobile application. The customized user friendly application has several buttons to control the appliances. A pi microcontroller will be located in a room and will be connected to all electronic devices in the home with the help of relays. The Raspberry pi can be controlled from any remote place with the help of Microsoft azure cloud service. Python GPIO library functions gives us a platform to interact with Raspberry pi's General Purpose IO pins. The Raspberry pi then either allows or prevents the current through an electromagnetic relay connected to the intended switch and this result in turning the device ON or OFF. Thus globally accessible automation of electronic appliances can be controlled with the use of a Raspberry Pi controller board, an internet connection and relay switches in a user friendly way. An algorithm has been proposed in this paper to automatically optimize the energy consumption based on calculating total power consumption of the home appliances [1].*

Key Words: **Home Automation; Raspberry pi; cloud services; Internet of Things- IOT.**

1.INTRODUCTION

Just imagine how convenient it will be to be able to turn ON your air conditioning system few minutes before you get home on a hot afternoon in summer and experience the chilled environment. How about turning ON and OFF any device remotely by observing the energy consumption of individual device for smart energy management without involving any cost in doing it .How about having a security system that will detect smoke and turn ON water outlets automatically rather than waiting for fire brigades [1]. This is what Home Automation is all about and there is no end to its development and application. Actually, sophisticated home automation systems are already developed that can maintain an inventory of household items and record their usage through an RFID (Radio Frequency Identification) technologies or mobile phones, ZigBee, Wi-Fi etc [2]. Home automation has made it possible to have what is called as a smart home. This will include a home that can detect and identify you, automatically adjust the lighting to your predefined intensity, open or close the doors automatically when you enter a room, play your favourite music whenever you need it, water your plants in the morning, automatically switch ON the security lights at night and switch them OFF in the morning, heat water for bath and tea, stream live video of what is happening in and around your house at your fingertips [1]. This makes it possible to link lighting, entertainment, heating, telecommunication and air conditioning facilities into one centrally controlled system. This will allow you to make your house an active friend in managing your busy life. In today's world, you can hardly find a house without automation system which can range from the remote control of the television, burglar alarm and to an automated air conditioning system that maintains the temperature at a predefined value as per your need.

In this paper we are proposing Home automation system to control the home appliance remotely using Android application. Smart Energy management algorithm has been proposed that includes switching the device OFF if it has reached maximum threshold value of power consumption. This will allow saving immense amount of power when any device is running unnecessarily.

2. Existing Home Automation Technologies.

There are many definitions that describe home automation system as the introduction to technology within the home to enhance the luxury and quality of life. It includes the provision of different services such as multimedia entertainment, biomedical and energy conservation. It has been detected that there has been significant research into the field of home automation.one of them is the X10 industry standard, which was developed in 1975 for communication between electronic devices and is the oldest standard identified from the author's review. Recently a home automation system was developed a Java based on embedded board that physically connected all the home automation devices which was integrated with a personal computer (PC)

based web server that gave remote access to the system [2]. The use of Java technology facilitated. built-in network security features and produces a secure and viable solution. But these systems required highly dense wired network that incurred expensive installation and the use of a high end computers involved. Then the Bluetooth technology was introduced in this system, consisting of a primary controller and a number of Bluetooth sub-controllers [2]. Each home appliance is physically connected to a local Bluetooth sub-controller in order to communicate with each other. Then these devices talk with their respective sub-controller using wired communications. Then from the sub-controller all communications messages are sent to the primary controller using wireless communications which is Bluetooth. It is expected for each home device to have a dedicated Bluetooth module. However, Bluetooth technology involved more expenses, and single module was shared amongst several devices [2]. But this method reduced the amount of physical wiring complexity and hence the addition of the installation, through the use of wireless technology. But due to the sharing of a single Bluetooth module between various devices has added the disadvantage of increase in access delay among the devices. Another technology was introduced which was phone based remote controller for home and office automation [4]. This system is different from all communications that occur over a fixed telephone line. There is no internet medium in between. The system can be reached using any telephone that supports dual tone multiple frequencies (DTMF). But the disadvantages of this system are : users do not have a graphical user interface, they have to remember an access code, and they have to remember which buttons to press to control the connected devices, which is little cumbersome. So this technology did not gain much popularity. Another model was proposed that included network, using hand gestures using image processing. To operate the controller uses a glove to instruct to the system using hand gestures [6]. But the problem with the system lies in the inaccuracy of hand gestures which may lead to unexpected actions to take place, because normal arm movements can be inaccurately interpreted as commands. Hence there is the risk of user fatigue if repetitive hand gestures are required. This introduction provides a small review of the existing academic research into home automation done in this area. The adoption of home automation technologies into commercial systems has been limited and not increased drastically over last few years. Also the consumer uptake has been slow. Various attempts have been made with help of home gateway systems to provide network interoperability along with remote access to automation system. In another solution a home gateway was considered as the point of communication between a personal area network and a public access network. Later on an idea as designed to introduce a web server based system that used home gateway to connect with IEEE 1394, along with a power line home automation system and Internet [5]. In order to make the system more attractive to home owners introduced a real time Audio Video transcoding capability. This system offers a depth look into the development of home gateway sub system. however the use of power lines as the communication medium puts a limitation on the positioning of devices within the home to areas close to power sockets. Later on another solution was proposed for home energy management focused home gateway system, which connected the home network with the Internet. This system was installed in twenty houses in the Tokyo area successfully. Another method was introduced using home gateway based on the Open Service Gateway Initiative done, that allows service providers to access home automation systems that provides administration and maintenance services to home held appliances. The proposed system is divided into two subsystems. The first is the DSM (Digital Home Service Distribution and Management System) [6]. These systems provide a user interface for the user control and monitoring of connected devices. The second method is the Home Gateway, which is responsible for managing the home automation system. This type of architecture raises privacy problems for some users that might have more importance over the advantages offered by granting third party access. Another user implemented a home gateway that accepted a mobile phone signals and activates or deactivates LED that represented a home device. So far these technologies have made important contribution to the development of a home gateway. Moreover, the existing research is focused on using the smart technology that includes an android device to control the home automation system using the concept of Internet of Things (IOT) [13].

3. SYSTEM OVERVIEW

We proposed the example of a system for controlling a remote Home appliance using a "Raspberry pi" card for receiving commands from an Android application on mobile phone in figure 1. The implementation of this system requires:

- The Programming of a Raspberry pi card capable of receiving commands (orders) sent by a remote user to turn ON and OFF the remote device or home appliance.
- The development of a mobile application "Android" in order to control our system.
- Communication interface between raspberry pi and web server.
- Implementation of registering and deregistering the commands in web server.
- Using Microsoft AZURE cloud service to deploy android application.
- Implement smart algorithm that will be decision maker on threshold value of power consumption. It will maintain database that will store the values of energy consumption on hourly weekly, daily, monthly with the average value of power consumption of each device as well as overall power.

3.1 Role of Raspberry pi in the system.

Raspberry pi is a credit-card sized computer aimed at providing a computer to every person in the world. Raspberry Pi is intended to provide a base on which kids can learn programming while enthusiasts can do different types of commercial programming. It serves as an efficient base due to its low cost and the number of interfaces available. The Raspberry Pi can be used instead of a personal computer, but with some limitations due to its limited processing power. In this implementation we are going to use the strengths of raspberry pi which acts as a controller. The user initiates the command – ON or OFF of the device from an android application. The command payload is stored into Microsoft Azure cloud. Microsoft Azure cloud service platform uses different queues and service bus to store this command which are then retrieved by Raspberry pi and processed further. The Raspberry pi decrypts the message and takes the actions accordingly and passes or blocks the current flowing through the device by turning the relay ON or OFF. We have used a current measurement IC-ACS712 to measure the current flowing through the device. The amount of energy consumed by the device is calculated and displayed to the user in android application. An algorithm has been developed that calculates the total power consumption of all the devices attached to the system. If the total power consumption exceeds the required threshold level an algorithm is triggered that will send the notification to the user to take appropriate actions. If the user does not respond to the Notification within provided timeout the algorithm will automatically turn OFF the device with least priority. The solution that we present is adopted for any home appliance equipment like Tube lights, Air conditioners, Fans, Fridge, Water-heater.

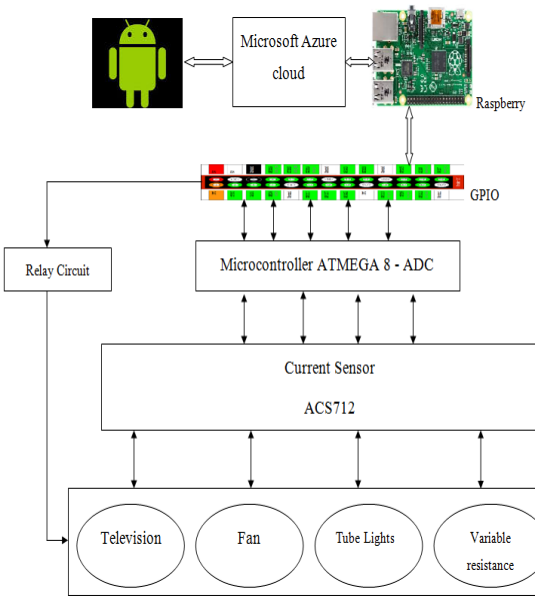

Fig-1: Block diagram for raspberry pi subsystem

4. Windows azure and service bus overview

We are going to use Microsoft Azure is a cloud computing platform and infrastructure created by Microsoft for building, deploying and managing applications and services through a global network of managed data centers. Windows Azure Service Bus service offers some great solutions to security and connectivity challenges in IOT scenarios which add to great comfort zone to the users. Integration with the Service Bus is more secure, because the actual device is only an one point of contact on the Internet where it can place messages or commands into a queue. The device will not be able to reach other protected network devices or resources inside cloud services. Using the Service Bus for device connectivity has facilitated less in terms of power, because the device can sleep frequently, and can be invoked or wakes up periodically to pull any waiting messages from the message queue from Azure.

The Service Bus provides more features like:

- It can Decouple end device communication and interaction from your cloud service platform.
- It also can enable load leveling and load balancing among several backend service.
- It identifies duplicate messages.
- messages are logically grouped (called Sessions)
- It has transactional behavior and atomicity
- Does on demand delivery of messages.

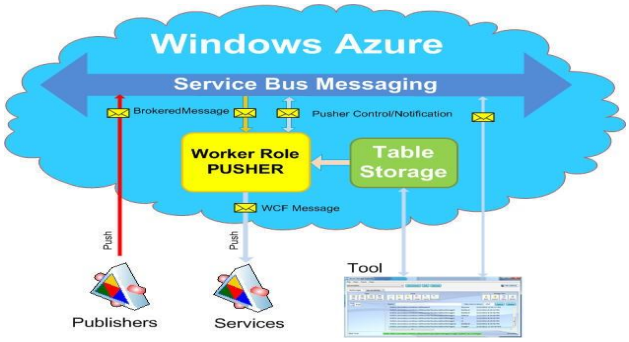

Fig-2: Windows azure service bus overview

Windows Azure Mobile Services platform has made it incredibly easy to connect a scalable cloud backend to your mobile applications. It provides a feature to easily store structured data in the cloud that can be used by both devices and users and integrate it with user authentication. It also sends out updates to clients via push notifications.

4.1 Storing Data in the Cloud

Storing of data is important in the cloud. With help of Windows Azure Mobile Services it has become incredibly easy to do it. When you create Azure Mobile Service, it automatically links with a SQL Database inside Windows Azure infrastructure. The backend then provides in built support for remote apps to securely store and retrieve data

from the database (using secure REST end-points utilizing a JSON-based format) – without developer to write or deploy any server code. Built-in support is provided within the Windows Azure portal in which one can create new tables, browsing data, setting indexes, and controlling access permissions to the database.

5. Android application schematic

The android application is capable of switching the home appliance ON or OFF, and display the status of the device. It also displays the power consumption of the device and pop up the notification once the threshold level of total power consumption of device is reached. The status of the device consists of two parameters i.e. Weather the device is ON or OFF and what is the current power consumption. The device can be configured to a priority that will be used to shut off the device when overall power consumption is exceeded. Figure below shows sample view of android GUI interface

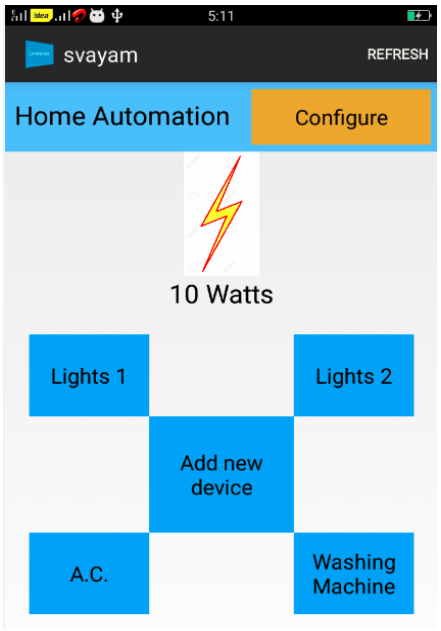

Fig-3: Android application GUI interface

6. Software Algorithm

Codes are developed on Azure cloud and raspberry pi. The Azure cloud implements a scheduler. The major responsibility of azure scheduler is to receive commands from android application and send it to raspberry pi. The raspberry pi will then pick up the commands and execute it and send back the response. After sending the command to raspberry pi Azure scheduler waits for the response from raspberry pi.

A. Flow chart for Android System.

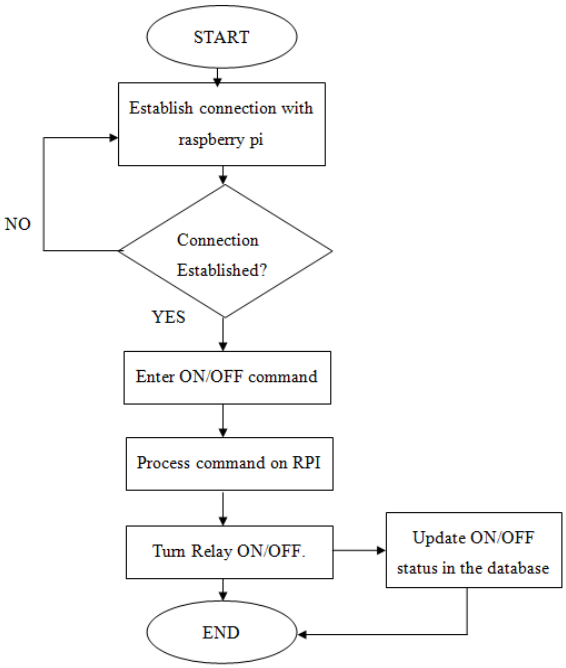

Chart-1: flow diagram for ON/OFF command.

B. Flow chart for Raspberry Pi system

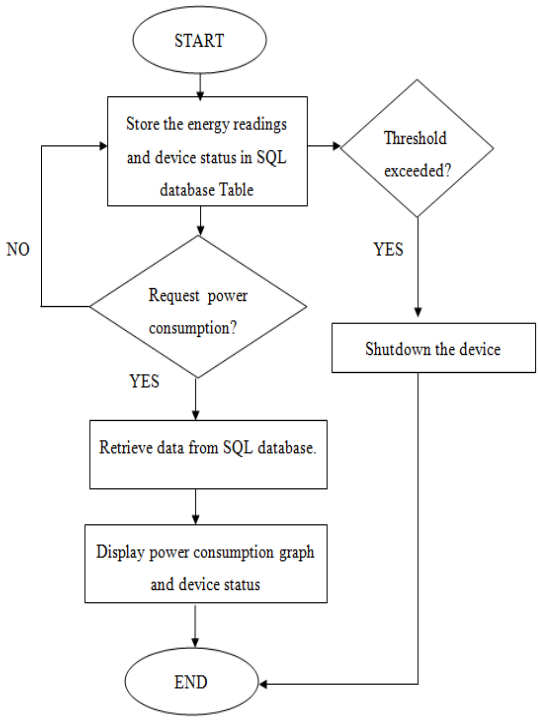

Chart-2: flow diagram for database read operation.

7. Performance Comparison With Existing Systems.

Early remote control devices began to emerge in the late 1800s. For example, Nikola Tesla patented an idea for the remote control of vessels and vehicles in 1898. The emergence of electrical home appliances began between 1915 and 1920 the decline in domestic servants meant that households needed cheap, mechanical replacements. Domestic electricity supply, however, was still in its infancy — meaning this luxury was afforded only the more affluent households. With the invention of the microcontroller, the cost of electronic control fell rapidly. Remote and intelligent control technologies were adopted by the building services industry and appliance manufacturers.

In 2004 A Alheraish proposed Design and Implementation of Home Automation System. It includes M2M Wireless communication of various machines and devices in mobile networks is used for discussion. They presented design and implementation of remote control system by means of GSM cellular communication network. The design integrated the device to be controlled, the microcontroller, and the GSM module so that it can be used for a wide range of applications. Detailed description and implementation of each design element was presented. To verify the principle operation of the M2M design, two home applications were experimentally tested using PC-based environment [1].

Later in 2005 M. van der werff, X Gui, and W.L. Xu Massey proposed mobile-based home automation system. This system presents home automation system that consists of a mobile phone with Java capabilities, a cellular modem, and a home server. The home appliances are controlled by the home server, which operates according to the user commands received from the mobile phone via the cellular modem. In our proposed system the home server is built upon an SMS/GPRS (Short Message Service/General Packet Radio Service) mobile cell module and a microcontroller, allowing a user to control and monitor any variables related to the home by using any java capable cell phone [2].

John Hastings stated A Smart Grid Information System for Demand Side Participation: Remote Control of Domestic Appliances to Balance Demand. The architecture and control methodologies of such a system on a large scale would require careful consideration are discussed. Some of the considerations are discussed. They include communications infrastructure, systems architecture, control methodologies and security. A domestic fridge is used in this paper as an example of a controllable appliance [3].

Rozita Teymourzadeh discussed Smart GSM Based Home Automation System. This research work investigates the potential of 'Full Home Control', which is the aim of the Home Automation Systems in near future. The analysis and implementation of the home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances such as light, conditional system, and security system via Short Message Service (SMS) text messages is presented in this paper [4].

Narender M and Vijayalakshmi M proposed Raspberry Pi based Advanced Scheduled Home Automation System through E-mail. The main aim of this paper is to develop an advanced method of home automation with the application of Raspberry Pi (RPi) through reading the subject of the E-mail. An algorithm for the same has been developed using the python environment which is by default provided by Raspberry Pi [5].

Chathura Withanage, Rahul Ashok discussed in brief about Comparison of the Popular Home Automation Technologies in this paper a comparison of popular home automation technologies is presented from user perspective to fill this void in the research literature, and to empower the users with more details based on the current home automation market. X10, ZWave, ZigBee, INSTEON,and EnOcean are the home automation technologies compared in this paper [6].

V. Sandeep, K.Lalith Gopal, S.Naveen, A.Amudhan, and L.S. Kumar have designed Globally Accessible Machine Automation Using Raspberry Pi Based on Internet of Things. To automate a machine, a secondary brain (another machine) is required to 'Think' and control machines to do tasks as per the convenience of the user from long distances. An automation system is proposed for the users to control home electronic appliances with high mobility and security. A set of switches will be controlled by internet with the use of a Raspberry pi micro-controller board [7].

Mahadi Abdul Jamil et al studied development of home automation system via raspberry pi. It is hoped that it will provide a better quality of life, while reducing the electricity wastage by giving user the power to control, conserve and react according to user needs, or also can be done by using the scheduling function for automatic operation of home appliances [8].

3. CONCLUSIONS

This work deals with smart home technology. The remote control of home device includes software and hardware components such as Azure cloud infrastructure, smart phone, Raspberry pi card and an energy measurement module [1]. Many codes have been developed and installed in the Microsoft Azure cloud, smart phone and the raspberry pi card. The power measurement module has introduced an additional smartness to this idea that will definitely help one to reduce or manage home appliances efficiently from any remote place. The notification mechanism is provided to the user once the threshold of power consumption is reached. We have provided an algorithm that will automatically turn OFF the devices once the total power consumption or per device power consumption goes above particular threshold level. The application has been written, compiled and Installed and tested on android studio. The proposed prototype is implemented using five home appliances with accurate results.

ACKNOWLEDGEMENT

The Throughout the journey of this work till the date, I realized more strongly how much selfless efforts and goodwill of others have helped me. There are too much efforts of gardener to yield the beautiful flowers. So I should not forget them while praising flower. It is a matter of gratification for me to pay my respects and acknowledgements to all those who have imparted knowledge and helped me to complete my report. First I would like to acknowledge the great contribution and support I received in this endeavor from my Project Guide Prof S. M. Turkane for his in depth knowledge, guidance and inspiration for will be of great importance to clarify any kind of problems likely to be met in the future. I expressed my sincere thanks to M.E. Coordinator Prof. S. G. Galande for his valuable guidance. I also thank Head of Department Prof. U. V. Patil for their valuable direction. I also thanks to my teachers for UG and PG level for their encouragement and support. I obliged towards all the staff members, librarians, my friends and most important my Family those supported directly and indirectly. Last but not least I am very much thankful to our Principal Dr. R. S. Jahagirdar and the College for cooperation and support in the entire course. I will keep my improvement curve on the rise and thereby enhance the reputation of my College.authors can acknowledge any person/authorities in this section. This is not mandatory.

REFERENCES

[1] A. Alheraish "Design and Implementation of Home Automation System", *IEEE Transactions on Consumer Electronics*, 1088 Vol. 50, November 2004

[2] M. Van Der Werff, X Gui, and W.L. Xu Massey "A Mobile-Based Home Automation System" Mobile Technology, Applications and Systems, 2005 2nd International Conference.

[3] John Hastings, David Laverty, and D John Morrow 'A Smart Grid Information System for Demand Side Participation: Remote Control of Domestic Appliances to Balance Demand" *Power Engineering Conference (UPEC), 2013 48th International Universities* 2013

[4] Rozita Teymourzadeh, Salah Addin Ahmed, Kok Wai Chan, and Mok Vee Hoong "Smart GSM Based Home Automation System" *IEEE Conference on Systems, Process & Control*, Kuala Lumpur, Malaysia, 2013.

[5] Narender M and Vijayalakshmi M "Raspberry Pi based Advanced Scheduled Home Automation System through E-mail" *IEEE International Conference on Computational Intelligence and Computing Research* 2014.

[6] Chathura Withanage, Rahul Ashok, and Chau Yuen Kevin Otto "A Comparison of the Popular Home Automation Technologies" *2014 IEEE Innovative Smart Grid Technologies* 2014.

[7] V. Sandeep, K.Lalith Gopal, S.Naveen, A.Amudhan, and L. S. Kumar "Globally Accessible Machine Automation Using Raspberry Pi Based on Internet of Things " *International Conference on Advances in Computing, Communications and Informatics (ICACCI)* . 2015.

[8] M. Mahadi Abdul Jamil and M. Shukri Ahmad "A Pilot Study: Development of Home Automation System via Raspberry Pi" *2015 2nd International Conference on Biomedical Engineering (ICoBE) - penang 2015*

[9] Hayet Lamine proposed Remote control of domestic equipment from an Android application based on Raspberry pi card in 15th international conference on Sciences and Techniques of Automatic control& computer engineering - STA'2014, Hammamet, Tunisia, December 21-23, 2014

[10] Li, B., Hathaipontaluk, "Intelligent oven in smart home environment," *International Conference on Research Challenges in Computer Science, pp. 247–250, Shanghai*. December 2009.

[11] Jonghwa Choi, Dongkyoo Shin, and Dongil Shin "Research on Design and Implementation of the Artificial Intelligence Agent for Smart Home Based on Support Vector Machine". *vol 3610. Springer, Berlin, Heidelberg*, 2005.

[12] Chen, C.-Y., Tsoul "Implementing the design of smart home and achieving energy conservation" *7th IEEE International Conference on Industrial Informatics (INDIN 2009), pp.273–276, Cardiff, Wales,* 2009.

[13] Li Jiang, Da-You Llu, and Bo Yang "Smart home research Proceedings of the Third International Conference on Machine Learning and Cybernetics", *vol. 2, pp. 659–663, Shanghai,* 2004.

[14] Salama et al had proposed Smart Home Activities: A Literature Review, Electric Power Components and Systems, 42(3–4):294–305, 2014.

[15] Morris ME, Adair B, Miller K, Ozanne E, Hansen R, et al., "Smart-Home Technologies to Assist Older People to Live Well at Home", Sci Journal of Aging Science, Volume 1, issue 1, 2013

[16] Al-Ali A. R et al "Java-based home automation system",IEEE Transactions on Consumer Electronics, vol. 50, no. 2, pp. 498-504 , 2003.

[17] Girish Birajda et al "Embedded webserver based home automation using raspberry pi", International Journal of Modern Trends in Engineering and Research,vol. 1, no.5 September 2014,India.

[18] Sarthak Jain et al "Raspberry pi based interactive home automation system through e-mail", 2014 International Conference on Reliability, Optimization and Information Technology - ICROIT 2014, India, Feb 6-8 2014.

[19] Vladimir Vujovic, Mirjana Maksimovic "Raspberry Pi as a Sensor Web node for home automation", 37th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2014.

[20] Shaiju Paul, Ashlin Antony and Aswathy.B "Android Based Home Automation Using Raspberry Pi", International Journal of Computing and Technology, vol. 1, no. 1, February 2014.

[21] Vujovic´V, Maksimovic´ et al M. Raspberry Pi as a wireless sensor node: performances and constraints. The 37th International ICT Convention – MIPRO 2014, ISSN 1847-3938, ISBN 978-953-233-078-6, Opatia, Croatia 2014. p. 1247–52.

[22] Kushirio N et al,"Integrated home gateway controller for home energy management system", IEEE International Conference on Consumer Electronics, pp. 386-387, 2003.

[23] https:// www.weaved.com