

IoT based Monitoring and Control System for Home Automation

Pavithra.D

M.E, Embedded System Technologies
TIFAC-CORE in Pervasive Computing Technologies
Velammal Engineering College, Surapet
Chennai - 600066, India
pavithradj4@gmail.com

Ranjith Balakrishnan

TIFAC-CORE in Pervasive Computing Technologies
Velammal Engineering College, Surapet
Chennai - 600066, India
ranjithbke@gmail.com

Abstract—The project proposes an efficient implementation for IoT (Internet of Things) used for monitoring and controlling the home appliances via World Wide Web. Home automation system uses the portable devices as a user interface. They can communicate with home automation network through an Internet gateway, by means of low power communication protocols like Zigbee, Wi-Fi etc. This project aims at controlling home appliances via Smartphone using Wi-Fi as communication protocol and raspberry pi as server system. The user here will move directly with the system through a web-based interface over the web, whereas home appliances like lights, fan and door lock are remotely controlled through easy website. An extra feature that enhances the facet of protection from fireplace accidents is its capability of sleuthing the smoke in order that within the event of any fireplace, associates an alerting message and an image is sent to Smartphone. The server will be interfaced with relay hardware circuits that control the appliances running at home. The communication with server allows the user to select the appropriate device. The communication with server permits the user to pick out the acceptable device. The server communicates with the corresponding relays. If the web affiliation is down or the server isn't up, the embedded system board still will manage and operate the appliances domestically. By this we provide a climbable and price effective Home Automation system.

Keywords—*Raspberry pi; Internet of Things; Web Server; Home Automation*

I. INTRODUCTION

Today, technology has become an integrated part of people's lives. It has, and continues to influence many aspects of daily life and has allowed better social interaction, ease of transportation, the ability to indulge in entertainment and media and has helped in the development in medicine. The creation of many devices such as mobile phones and computers have caused many people to rely on technology to communicate with their friends, store information such as pictures, movies, documents, and music. The internet has become a common interface that many devices use in order to simplify the daily life of many people. Internet helps us to bring in with immediate solution for many problems and also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption.

Home automation or sensible home may be delineated as introduction of technology within the home atmosphere to provide ease and protection to its occupants. By using the technology of the Internet of Things, the examination and execution of home automation have got additional average. Various wireless technologies which is able to support some sort of remote knowledge transfer, sensing and management like Bluetooth, Wi-Fi and cellular networks are used to enter abundant levels of acumen within the home. Home automation for the older and disabled will offer raised quality of life for persons [1]. It may provide an interface to home appliances or the automation system itself, via telephone line or the internet, to supply management and observance via a smart phone or personal computer.

The Internet might even be utilized in home automation that offers several decisions from economical use of energy to additional console, protection and safety. Even over great distances the user can monitor and manage their home gate, various appliances and turn on/off the T.V without any human intervention. Despite these advantages, home automation has however received extensive approval and an attention owing to its high significance and complexness [2]. This paper will describe an approach in which we implement a controlling and continuous monitoring system to control various home appliances with Android smart phone.

II. INTERNET OF THINGS

The Internet of things (IoTs) can be defined as connecting the various types of objects like smart phones, personal computer and Tablets to internet, which brings in very new-fangled type of communication between things and people and also between things. With the introduction of IoTs, the research and development of home automation are becoming popular in the recent days. Many of the devices are controlled and monitored for helps the human being. Additionally various wireless technologies help in connecting from remote places to improve the intelligence of home environment. An advanced network of IoT is being formed when a human being is in need of connecting with other things. IoTs technology is used to come in with innovative idea and great growth for smart homes to improve the living standards of life.

A. IoT Architecture

The IoT-based architecture provides high-level flexibility at the communication and information. It is an approach which is relevant in many different environments such as patient monitoring system, security, traffic signal control or controlling various applications. The IoT project aims to bring out the various opportunities of using IPv6 and other related standards to overcome the disadvantages using of the Internet of Things [3]. The IoT projects proves a dominant and thorough study of all sensible functionalities, mechanisms and various protocols that can be used for building IoT architectures however interconnections may occur between all totally different IoT applications.

As in the networking field, where several solutions emerged at his infancy to leave place to a common model, the TCP/IP protocol suite, the emergence of a common reference model for the IoT domain and the identification of reference architectures can lead to a faster, more focused development and an exponential increase of IoT-related solutions. These solutions can provide a strategic advantage to mature economies, as new business models can leverage those technological solutions providing room for economic development.

III. 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. This work is designed in such a way to avoid the disadvantages of the existing system. The proposed system supports more elasticity, comfort capacity and safety.

The main objectives is to design and to execute an cost effective and open source home automation system that's capable of leading most of the home and sustain the house automation system. The predictable system contains a great elasticity by using wireless reliable technology to interconnecting various modules to the server of home automation system. This in turn reduces the deployment cost; will add to the flexibility of advancement, and system reconfiguration. The projected system can make use of wireless LAN(Local space Network) connections between various sensor, hardware modules and server, and various communication protocols between users and server[4].

The block diagram of proposed system is shown in Fig. 1. The Infrared sensor (IR) is a low cost infrared object detection unit that we can be applied at home using IR LED's. It gets trigged when light is detected. When the sensor is sensed it sends a signal to raspberry pi. From the raspberry pi, by means of wifi configuration and IoT concept we can turn ON/OFF the light. Similar to IR, the PIR sensor is used to detect the human being presence and accordingly the fans are turned ON/OFF. The lights and fans can be controlled by creating web server in personal computer, tablet or we can create an app in mobile.

Finally the fire detection sensor is triggered if there is any fire accident and immediately an alert message along with the image and video taken in camera is sent to mobile phone and an automatic phone call is made to nearby fire station. By using

mobile phone we can overcome the disadvantages of sending message to E-mail [5] such as possibilities of the attachment may contain virus, due to many spam messages the emergency mail could not be viewed and user has to login with email id and password which causes a time delay.

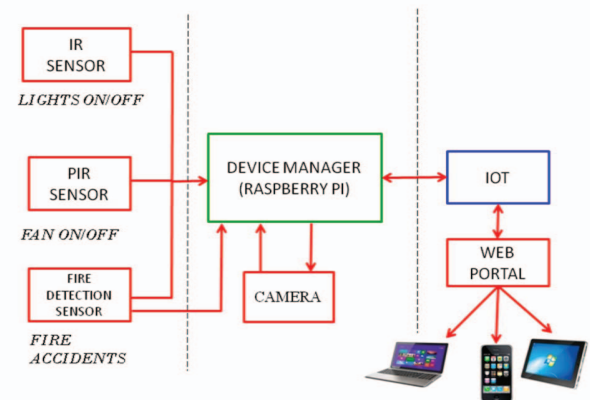


Fig. 1. Architecture of proposed solution

IV. SYSTEM DESIGN

A. Sensor and Camera Interfacing

The IR sensor module is easy for operation. IR sensors detect infrared light, which is used to turn ON/OFF of lights. Passive Infra Red (PIR) sensor has been used to detect human. The PIR sensors are tuned to detect when a human being or an animal arrives in their proximity. [6].

The fire detection sensor consists of a Light Dependent Resistor (LDR) which gets sensed when fire is detected. This will help to take immediate actions if there is any fire accident [7]. A camera is attached by which if fire is being detected, the camera takes the snapshot of the accident and sends it to smart phone by which the user can take the immediate action.

B. Raspberry pi

The Raspberry Pi is a low cost credit card sized single-board computer developed by raspberry pi foundation. Raspberry pi is controlled by a modified version of Debian Linux optimized for the ARM architecture. The core of the home automation system is this minicomputer [8]. Here we are using model B plus. The setting up of raspi consists of selecting raspbian OS from prebuilt SD card. The prebuilt SD card consists of raspbian, arclinux, pidora, open ELEC, risc OS operating system. After the OS selection we need to configure raspberry-pi using Raspi-config command. We can enter into raspi desktop using startx command.

C. 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. We may use `sudo nano /etc/network/interfaces` for configuring wifi with raspberry-pi. The Raspberry pi configuration using raspi-config command is shown in the Fig. 2.

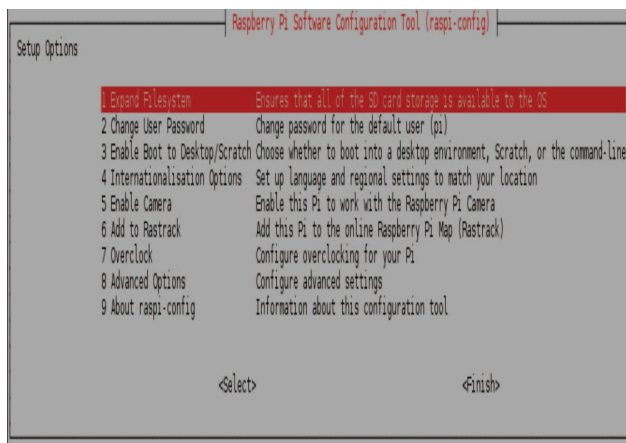


Fig. 2. Raspberry pi Configuration

D. Proposed IoT Architecture

The physical layer consists of the devices which are to be controlled. The data link layer consist of IoT gateway router, device manager and various communication protocols. The device manager will be the part of raspberry pi. The raspberry pi is used as the IoT gateway which communicates to personal computer or smart phone by means internet in the network and transport layer. The application and presentation layer consist of web portal which is nothing but designing a web page by which we can control the various appliances [9]. The appliances can also be controlled by creating an app in mobile phone which is similar to web portal. Smart phones can be used to take the immediate action if there is an emergency and it will automatically connect to nearby fire station in case of any fire accidents. The layer of IoT for the proposed solution is shown in the Fig 3.

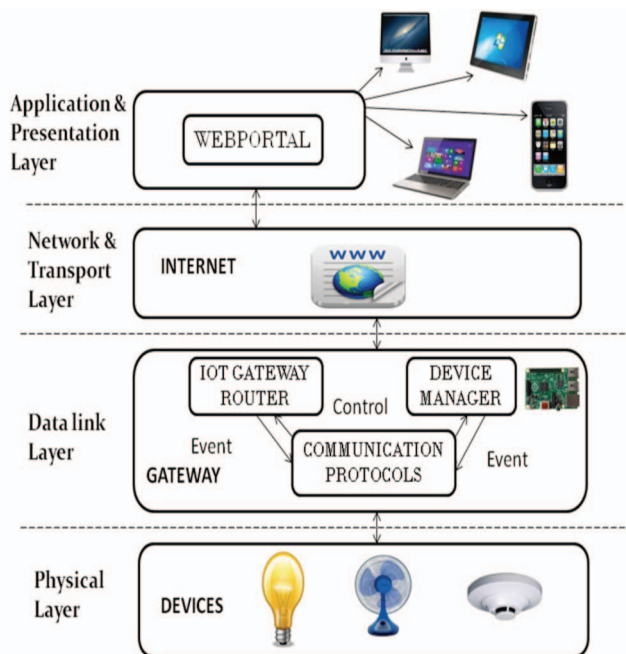


Fig. 3. Layers of IoT for Proposed Solution

E. Web Server

Various applications located at home can be remotely controlled or monitored by implanting the devices with the web server. The static and dynamic information are stored in embedded system and it fulfills the demands on web browsers. Such type of web servers are called embedded web server. [10]. It's not solely that we will use the Raspberry Pi to induce the information from servers via the web; however it also can act as a server itself. There are many alternative web servers that may be installing on the Raspberry Pi. Ancient web servers, like Apache, serve the files from Raspberry pi board to purchasers. Raspberry pi also can serve sound, video, workable programs, and far a lot [11]. However, there's a new breed of tools that reach programming languages like Python, Ruby, and JavaScript to make net servers that dynamically generate the hypertext mark-up language once they receive communications protocol requests from an online browser. A sample web page is shown in the Fig. 4.

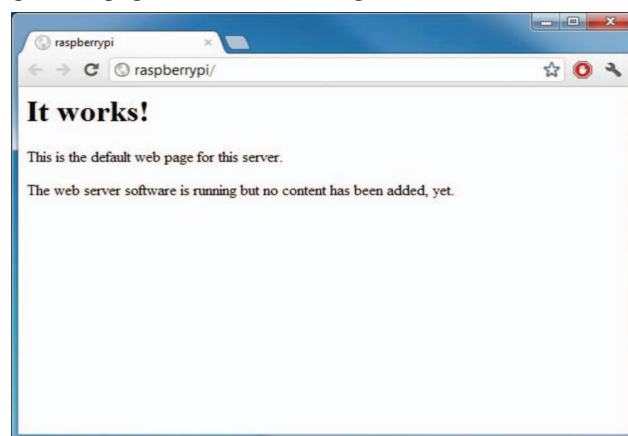


Fig. 4. Sample Webpage

F. User Interface

User interface is everything that the user will see and act with. During this module the android enabled phone makes control of the house automation system. Android based Smartphone provides a range of pre-build program parts like structured layout objects and program controls that enables us to create the graphical program for our app. Android also provides other User interface modules for special interfaces such as dialogs, notifications, and menus. The interface should enable the user to look at the device status and to regulate device.

V. IMPLEMENTATION DETAILS

The implementation of this work starts with selecting the operating system that we prefer. In this project we have selected raspbian operating system [12]. Now, we have to boot the operating system that we have selected with the necessary configurations. The various configurations which can be done are such as changing the password for default user, choosing whether to boot into a desktop environment, scratch, or the command line, enabling camera etc. The configuration settings are done according to the users need.

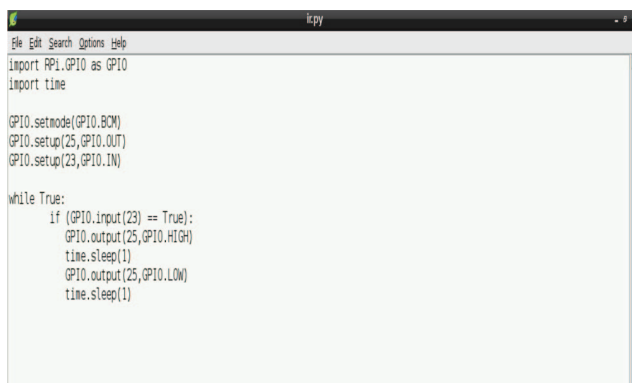


Fig. 5. Leaf Pad

After the configuration settings are done, the python program is to be typed in the leaf pad. Leaf pad is created by file manager->right click->create->blank file->enter a file name.py- > click ok. The leaf pad is shown in the Fig. 5. Next the program is saved [13] and it is executed by means of the LX terminal which is shown in the Fig. 6. LX terminal is used to view the status of various interfaces and results of all the inputs given to the raspberry pi.

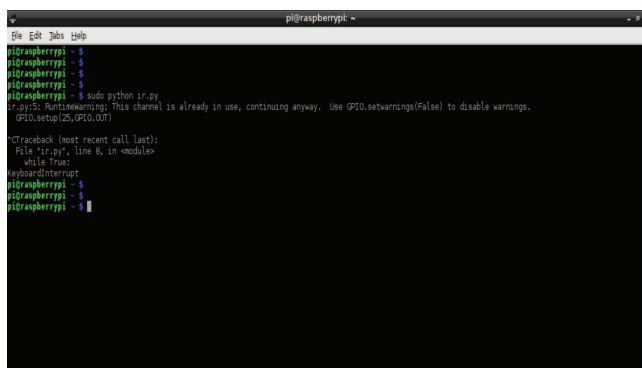


Fig. 6. LX terminal

The numerous sensors are interfaced [14] using python programming language with Raspberry pi and the output is viewed in personal computer. The various sensor interfaces are shown in the Fig. 7.

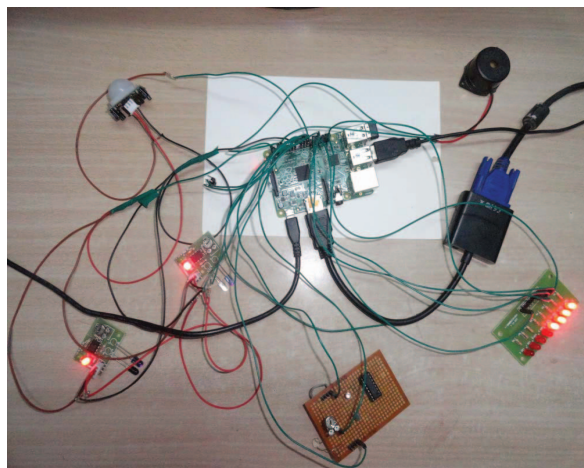


Fig. 7. Sensor Interfacing

After all the sensor being interfaced, by using the concept of IoT technology the various devices like Lights ON/OFF, Fan ON/OFF etc can be controlled. A web portal is being created where the devices can be controlled and monitored. The same can be implemented in android smart phone for continuous monitoring and control. If there is any sudden fire attack, we can view the image of the accident and how dangerous it is, simultaneously an automatic call to nearby fire station is implemented.

A web page is designed such that we can control and monitor the home. The same can be implemented in an android smart phone where we can take immediate action if there is any emergency as well can control and monitor the home from remote places. The raspberry pi home page where the user can log in with their username and password is shown in the Fig. 8.

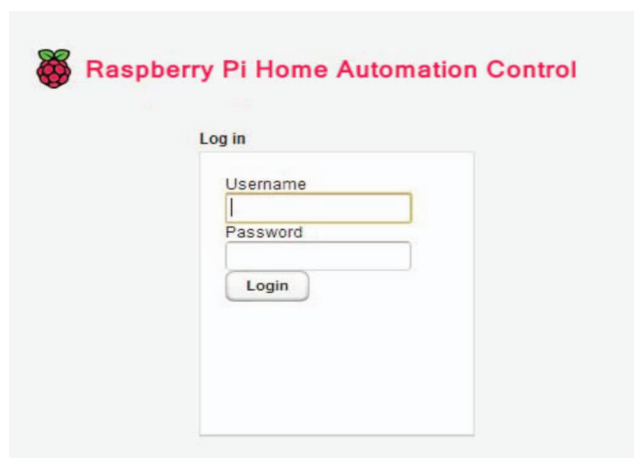


Fig. 8. Raspberry pi home page

After getting logged into home automation system by means of user name and password, the various rooms are visible with various devices. We can view status of all lights and fans in each of the room whether they are turned ON/OFF. The same can be implemented in a mobile/home for continuous monitoring. We can view all the rooms in the home with various devices, where we can select the rooms which we want to control.

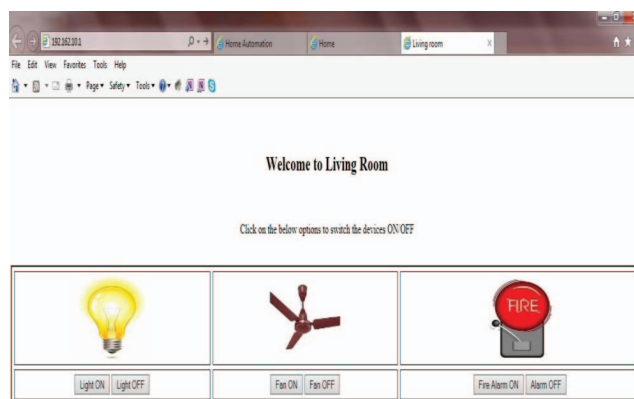


Fig. 9. Living room with various devices

The living room with various devices to be controlled in seen in the Fig. 9. Now the devices can be turned ON/OFF by means of the users wish. The GPIO (General Purpose Input Output) is used by which the user can interface the various sensors to raspberry pi. So when the sensors are sensed, the GPIO is enabled. As a result we can view the change in the status of the devices by means of Smartphone and PC [15].

One of the most important advantages of this work is that the devices can be controlled and monitored in any of the operating system in mobiles i.e. in both windows and android. The control of various appliances by means of GPIO in another laptop can be viewed in Fig. 10. The control and monitor of the devices can be done by using the technology Internet of Things.



Fig. 10. Controlling the appliance by means of GPIO in a webpage

VI. CONCLUSION AND FUTURE APLLICATIONS

In this paper, we have introduced the event of a home management and security system exploitation using Raspberry pi and Internet of Things technology. The system is suitable for real-time home safety monitoring and for remotely controlling the home appliances and protection from fire accidents with immediate solutions. The system may be employed in many places like banks, hospitals, labs etc that dramatically cut back the hazard of unauthorized entry. Proof may be given to the safety department if any theft issue happens.

The various future applications may be used by controlling various household devices of house with internet, Industrial automation and management through internet, machine-driven fireproof exit systems and improvement of security problems in extremely restricted areas.

REFERENCES

- [1] Atzori, Luigi, Antonio Iera, and Giacomo Morabito. "The internet of things: A survey." *Computer networks* 54.15 (2010): 2787-2805.
- [2] Al-Ali, Abdul-Rahman, and Mohammad Al-Rousan. "Java-based home automation system." *Consumer Electronics, IEEE Transactions on* 50.2 (2004): 498-504.
- [3] Kelly, Sean Dieter Tebje, Nagender Kumar Suryadevara, and Subhas Chandra Mukhopadhyay. "Towards the implementation of IoT for environmental condition monitoring in homes." *Sensors Journal, IEEE* 13.10 (2013): 3846-3853.
- [4] Zhang, Weizhe, and Baosheng Qu. "Security Architecture of the Internet of Things Oriented to Perceptual Layer." *International Journal on Computer 2* (2013): 2-13.
- [5] Jain, Sarthak, Anant Vaibhav, and Lovely Goyal. "Raspberry Pi based interactive home automation system through E-mail." *Optimization, Reliability, and Information Technology (ICROIT), 2014 International Conference on. IEEE*, 2014.
- [6] Zhao, Yanbo, and Zhaohui Ye. "A low cost GSM/GPRS based wireless home security system." *Consumer Electronics, IEEE Transactions on* 54.2 (2008): 567-572.
- [7] Assaf, Mansour H., et al. "Sensor based home automation and security system." *Instrumentation and Measurement Technology Conference (I2MTC), 2012 IEEE International. IEEE*, 2012.
- [8] Chowdhury, Md Nasimuzzaman, Md Shiblee Nooman, and Srijan Sarker. "Access Control of Door and Home Security by Raspberry Pi Through Internet." *International Journal of Scientific and Engineering Research* 4 (2013).
- [9] Moreno, M., et al. "A holistic IoT-based management platform for smart environments." *Communications (ICC), 2014 IEEE International Conference on. IEEE*, 2014.
- [10] Gubbi, Jayavardhana, et al. "Internet of Things (IoT): A vision, architectural elements, and future directions." *Future Generation Computer Systems* 29.7 (2013): 1645-1660.
- [11] Fang, Shifeng, et al. "An Integrated System for Regional Environmental Monitoring and Management Based on Internet of Things." *IEEE Trans. Industrial Informatics* 10.2 (2014): 1596-1605.
- [12] Download the Required Operating System in <http://www.raspberrypi.org/downloads/>.
- [13] Steven Goodwin. "Smart Home Automation with Linux" Copyright © 2010 by Steven Goodwin.
- [14] Y. Daniel Liang "Introduction to Programming Using Python" Copyright © 2013 Pearson Education, Inc., publishing as Prentice Hall.
- [15] Mark lutz. "Programming Python", O'Reilly, 3rd edition, August 2006.