

# IoT Based Monitoring & Control System for Home Automation using Raspberry Pi

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**Abstract:** Home automation is an important milestone in achieving smart grid and is ever exciting field that has exploded over the past few years. Advancement in technologies have made homes more convenient, efficient and even more secure. The main objective of present work 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 Zig bee, 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. The server will be interfaced with relay hardware circuits that control the appliances running at home. If the web affiliation is down or the server isn't up, the embedded system board still will manage and operate the appliances domestically. The main advantage of this is small device can be part of internet so it is easy to communicate, manage and control without human interferences. Also, it provides high degree of security, safety, comfort and energy saving.

**Keywords:** Home automation, Internet of things, Raspberry Pi, Web Server, Relay.

## 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.



Fig. 1: Home automation using Raspberry pi

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 of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, and network connectivity, which enables these objects to collect and exchange data [2]. The major element of home automation based on IoT is sensor network and raspberry pi. Sensor networks are used for sensing and monitoring while raspberry pi collect the data monitor the data and depends on collected mange the device like fan, light, door motion and opening-closing of curtains. Suppose the ambient light is less that I am going to feel darkness then according to ambient light its automatically open the curtains. 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 [3]. 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 newfangled 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. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure. The concept of the Internet of Things first became popular in 1999, through at MIT and related market analysis publication. 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.

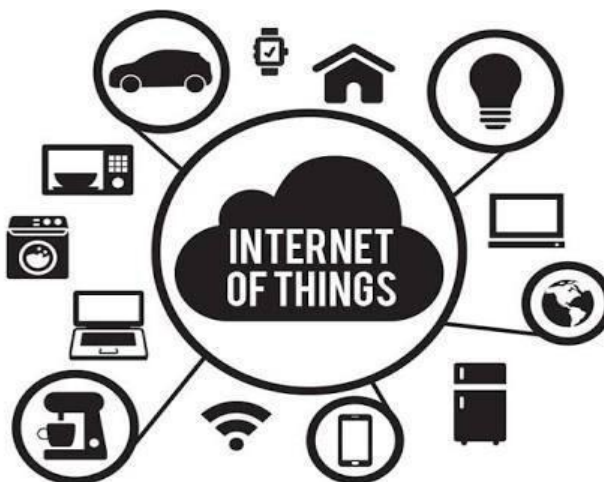


Fig. 2: Internet of Things

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. The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.

### 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 [4]. 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 [5].

The block diagram of proposed system is shown in Fig. 3. 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 Wi-Fi 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 [6] 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.

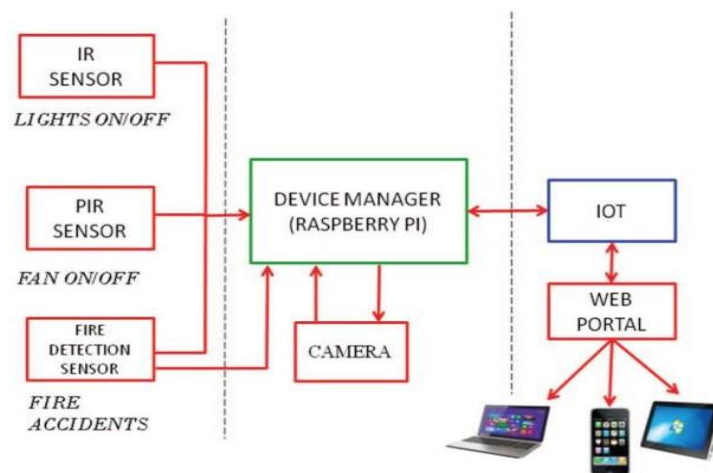


Fig. 3: Architecture of proposed solution

### 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 [7]. 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 [8]. 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 [9]. 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. Wi-Fi Router Configuration

The Wi-Fi unit provides the medium for communication. It can be also configured to make security services. The Wi-Fi should be configured with a certain address and user commands will be directing through Wi-Fi unit. We may use `sudo nano /etc/network/interfaces` for configuring Wi-Fi with raspberry-pi. The Raspberry pi configuration using `raspi-config` command is shown in the Fig.4.

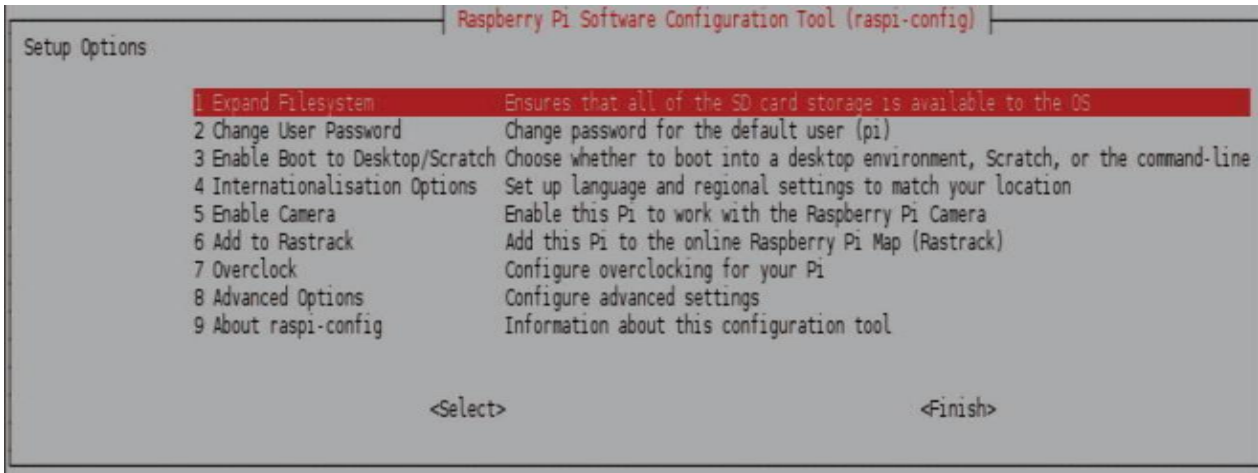


Fig. 4: Raspberry pi Configuration

### 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 [10]. 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 5.

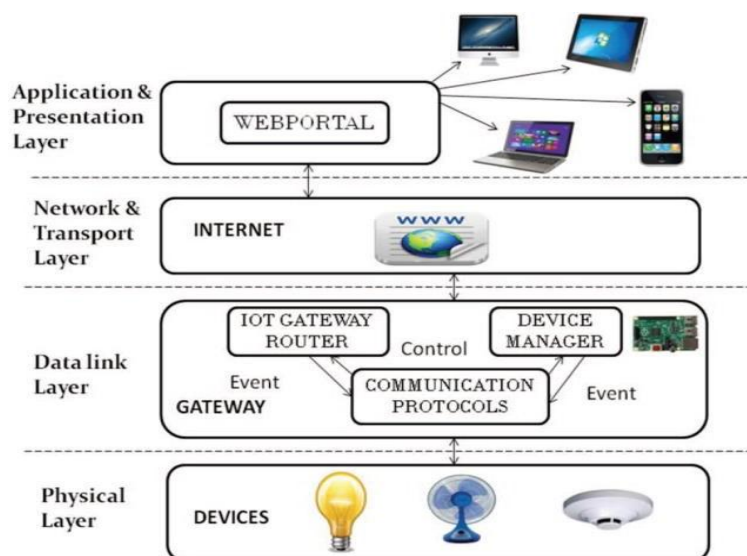


Fig.5: Layers of IoT for Proposed Solution

### E. Web Server

Various applications located at home can be remotely controlled or monitored by implanting the devices with the web server. There are many alternative web servers that may be installing on the Raspberry Pi. 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. 6



Fig.6: 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 [11]. 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.

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 Fig. 7. Next the program is saved [12] and it is executed by means of the LX terminal. LX terminal is used to view the status of various interfaces and results of all the inputs given to the raspberry pi. The numerous sensors are interfaced [13] using python programming language with Raspberry pi and the output is viewed in personal computer.

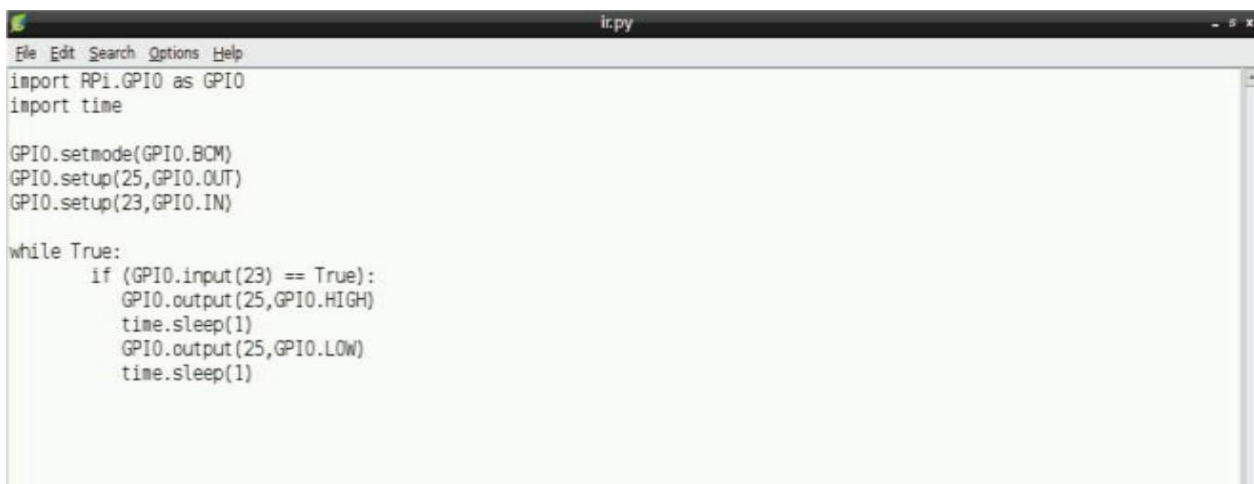


Fig.7: Leaf Pad

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 is seen in the Fig. 9. Now the devices can be turned ON/OFF by means of the user's 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 [14].

## VI. CONCLUSION

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 application of the IoT technology, in home automation means combination of all electrical devices like smart mobile phone, personal computer, tablet and their monitoring, controlling and alerting in ways not possible before. This proposed system provides many advantages including, safety, security, improved comfort, energy and cost savings. This system is also equipped with automated lights and virtual switches for controlling lights and appliances in the home remotely using external or internal networking with the Raspberry Pi via an HTML page. Full functionality of prototype indicates that devices like Raspberry Pi can play a very important role in designing smart homes of the future at very low cost. An energy aware smart home can be developed using Raspberry Pi.

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