CHAPTER-1

INTRODUCTION

1.1. Home Automation

Home automation is the residential extension of building automation. It is automation of the home, housework or household activity. Home automation may include centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, security locks of gates and doors and other systems, to provide improved convenience, comfort, energy efficiency and security. Home automation for the elderly and disabled can provide increased quality of life for persons who might otherwise require caregivers or institutional care.

A home automation system integrates electrical devices in a house with each other. The techniques employed in home automation include those in building automation as well as the control of domestic activities, such as home entertainment systems, houseplant and yard watering, pet feeding, changing the ambiance "scenes" for different events (such as dinners or parties), and the use of domestic robots. Devices may be connected through a home network to allow control by a personal computer, and may allow remote access from the internet. Through the integration of information technologies with the home environment, systems and appliances are able to communicate in an integrated manner which results in convenience, energy efficiency, and safety benefits.

Home automation has been a feature of science fiction writing for many years, but has only become practical since the early 20th Century following the widespread introduction of electricity into the home, and the rapid advancement of information technology. 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.

Ideas similar to modern home automation systems originated during the World's Fairs of the 1930s. Fairs in Chicago (1934), New York (1939) and (1964–65), depicted electrified and automated homes. In 1966 Jim Sutherland, an engineer working for Westinghouse Electric, developed a home automation system called "ECHO IV"; this was a private project and never commercialized. The first "wired homes" were built by American hobbyists during the 1960s, but were limited by the technology of the times. The term "smart house" was first coined by the American Association of House builders in 1984. 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.

By the end of the 1990s, "domotics" was commonly used to describe any system in which informatics and telematics were combined to support activities in the home. The phrase is a neologism formed from domus (Latin, meaning house) and informatics, and refers to the application of computer and robot technologies to domestic appliances. The concept "Domotique" was initially introduced in France in the 1980s and was during the 1990`s introduced in Spain and Italy as "Domótica", and refers to home automation.

Despite interest in home automation, by the end of the 1990s there was not a widespread uptake, with such systems still considered the domain of hobbyists or the rich. The lack of a single, simplified, protocol and high cost of entry has put off consumers. While there is still much room for growth, according to ABI Research, 1.5 million home automation systems were installed in the US in 2012, and a sharp uptake could see shipments topping over 8 million in 2017.

1.1.1. Importance and benefits

The household activities are automated by the development of special appliances such as water heaters to reduce the time taken to boil water for bathing and automatic washing machines to reduce manual labour of washing clothes. In developed countries, homes are wired for electrical power, doorbell, TV outlets, and telephones. The different application includes when a person enters the room, the light turns on. In advanced technology, the room can sense the presence of the person and who the person is.

Taking into account the day of the week, time of the day and other such factors it can also set apt lighting, temperature levels, television channels or music levels. In the case of a smoke detector when fire or smoke is detected, the lights in the entire house begin to blink to alert the resident to the probable fire. In case of a home theatre, the home automation system can avoid distraction and lock the audio and video components and can also make an announcement. The home automation system can also dial up the house owner on their mobile phone to alert them or call any alarm monitoring company.

Home automation refers to the use of computer and information technology to control home appliances and features (such as windows or lighting). Systems can range from simple remote control of lighting through to complex computer/micro-controller based networks with varying degrees of intelligence and automation. Home automation is adopted for reasons of ease, security and energy efficiency. In modern construction in industrialized nations, most homes have been wired for electrical power, telephones, TV outlets (cable or antenna), and a doorbell. Many household tasks were automated by the development of specialized automated appliances. For instance, automatic washing machines were developed to reduce the manual labor of cleaning clothes, and water heaters reduced the labor necessary for bathing.The use of gaseous or liquid fuels, and later the use of electricity enabled increased automation in heating, reducing the labor necessary to manually refuel heaters and stoves. Development of thermostats allowed more automated control of heating, and later cooling.

As the number of controllable devices in the home rises, interconnection and communication becomes a useful and desirable feature. For example, a furnace can send an alert message when it needs cleaning or a refrigerator when it needs service. If no one is supposed to be home and the alarm system is set, the home automation system could call the owner, or the neighbors, or an emergency number if an intruder is detected. In simple installations, automation may be as straightforward as turning on the lights when a person enters the room. In advanced installations, rooms can sense not only the presence of a person inside but know who that person is and perhaps set appropriate lighting, temperature, music levels or television channels, taking into account the day of the week, the time of day, and other factors.Other automated tasks may include reduced setting of the heating or air conditioning when the house is unoccupied, and restoring the normal setting when an occupant is about to return. More sophisticated systems can maintain an inventory of products, recording their usage through bar codes, or an RFID tag, and prepare a shopping list or even automatically order replacements.

Home automation can also provide a remote interface to home appliances or the automation system itself, to provide control and monitoring on a smartphone or web browser.An example of remote monitoring in home automation could be triggered when a smoke detector detects a fire or smoke condition, causing all lights in the house to blink to alert any occupants of the house to the possible emergency. If the house is equipped with a home theater, a home automation system can shut down all audio and video components to avoid distractions, or make an audible announcement. The system could also call the home owner on their mobile phone to alert them, or call the fire department or alarm monitoring company.

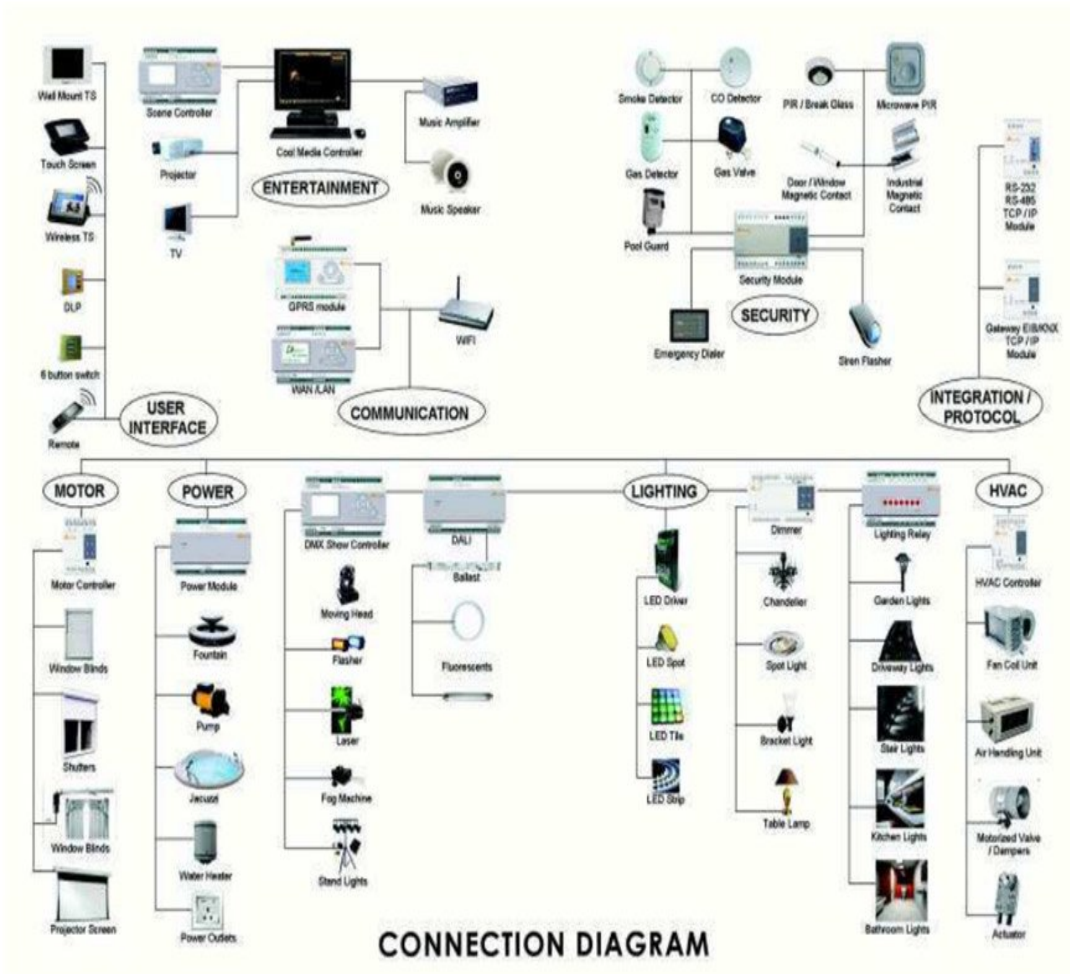

Fig. 1.1: Connection diagram

1.1.2. System Elements

There have been many attempts to standardize the forms of hardware, electronic and communication interfaces needed to construct a home automation system. Some standards use additional communication and control wiring, some embed signals in the existing power circuit of the house, some use radio frequency (RF) signals, some can be installed wirelessly and some use a combination of several methods. Control wiring is hardest to retrofit into an existing house. Some appliances include a USB port that is used for control and connection to a domotics network. Protocol bridges translate information from one standard to another, for example, from X10 to European Installation Bus (EIB now KNX).

Elements of a home automation system include; sensors (such as temperature, daylight, or motion detection); controllers (such as a general-purpose personal computer or a dedicated automation controller); actuators, (such as motorized valves, light switches and motors); buses (wired or wireless); and interfaces (human-machine and / or machine-to-machine).

One or more human-machine and/or machine-to-machine, interface devices are required, so that the residents of the home can interact with the system for monitoring and control; this may be a specialized terminal or, increasingly, may be an application running on a smart phone or tablet computer. Devices may communicate over dedicated wiring, or over a wired network, or wirelessly using one or more protocols. Building automation networks developed for institutional or commercial buildings may be adapted to control in individual residences. A centralized controller can be used, or multiple intelligent devices can be distributed around the home.

1.1.3. Tasks

1.1.3.1. HVAC

Heating, ventilation and air conditioning (HVAC) systems can include temperature and humidity control, including fresh air heating and natural cooling. An Internet-controlled thermostat allows the homeowner to control the building's heating and air conditioning systems remotely. The system may automatically open and close windows to cool the house.

1.1.3.2. Lighting

Lighting control systems can be used to control household electric lights. Lights can be controlled on a time cycle, or arranged to automatically go out when a room is unoccupied. Electronically controlled lamps can be controlled for brightness or color to provide different light levels for different tasks. Lighting can be controlled remotely by a wireless control or over the Internet. Natural lighting can be used to automatically control window shades and draperies to make best use of natural light.

1.1.3.3. Audio-visual

This category includes audio and video switching and distribution. Multiple audio or video sources can be selected and distributed to one or more rooms and can be linked with lighting and blinds to provide mood settings.

1.1.3.4. Shading

Automatic control of blinds and curtains can be used for:

- Presence simulation
- Privacy
- Temperature control
- Brightness control
- Glare control
- Security (in case of shutters)

1.1.3.5. Security

A household security systems integrated with a home automation system can provide additional services such as remote surveillance of security cameras over the Internet or central locking of all perimeter doors and windows. With home automation, the user can select and watch cameras live from an Internet source to their home or business. Security systems can include motion sensors that will detect any kind of unauthorized movement and notify the user through the security system or via cell phone.The automation system can simulate the appearance of an occupied home by automatically adjusting lighting or window coverings. Detection systems such as fire alarm, gas leak, carbon monoxide, or water leaks can be integrated. Personal medical alarm systems allow an injured home occupant to summon help.

1.1.3.6. Intercoms

An intercom system allows communication via a microphone and loud speaker between multiple rooms. Integration of the intercom to the telephone , or of the video door entry system to the television set, allowing the residents to view the door camera automatically.

1.1.3.7. Domotics

Journalist Bruno de Latour coined the term domotic in 1984. Domotic has been recently introduced in vocabulary as a composite word of Latin word domus and informatics and it refers to intelligent houses meaning the use of the automation technologies and computer science applied to the home. The term covers a range of applications of information technology to the problems of home automation. Domotics is the study of the realization of an intelligent home environment. Digital Home includes home automation, multimedia, telecommunications, e-commerce, etc. through home network .Domotics and home automation means that systems talk to each other for improved convenience, efficiency and safety.

1.1.3.8. Other systems

Using special hardware, almost any household appliance can be monitored and controlled automatically or remotely, including cooking appliances, swimming pool systems, and others.

1.2. What our project aims at?

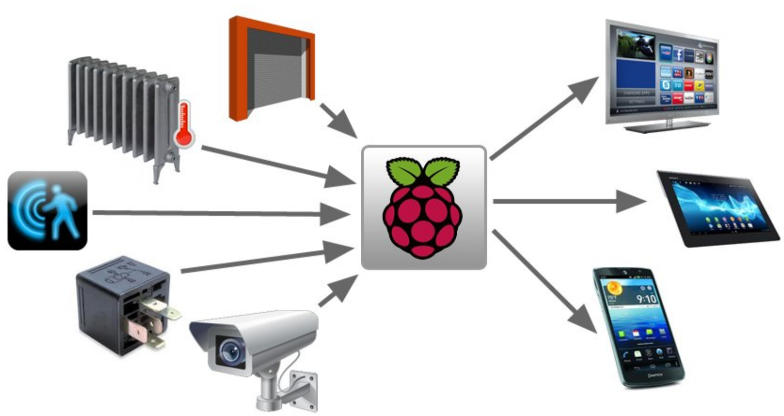

Fig.1.2: Raspberry Pi interface with devices

The goal of this project is to build a complete home automation system based on open-source hardware. By means of this project, we intend to put together a home automation system which has both voice recognition and email based functionality. In both home security systems and home automation systems, you’ve got a lot of the same things: sensors, servers, monitoring, alerts, etc. This project primarily deals with automating electronics at a domestic level in an easier and user-friendly way.

Fig.1.3: Raspberry Pi model B+ kit

Fig.1.4: Control of Home appliances with phone using RPi

CHAPTER-2

PROJECT DEFINITION AND REQUIREMENT

2.1. Raspberry Pi

Fortunately the technology related to home automation has progressed enormously in the last few years and new pieces of hardware have been developed which provide easy solutions to the above problems. The first important piece of the puzzle has emerged at the beginning of the year 2012, when the Raspberry Pi computer was officially released. The Raspberry Pi is a small, noiseless computer, which has a very low power consumption (typically 1-2 Watts) and is very lightweight. It takes up little space in the room and most importantly it is cheap. In other words it is the perfect choice for a computer to control the lights in your home.

The Raspberry Pi is a computer, very like the computers with which you're already familiar. It uses a different kind of processor, so you can't install Microsoft Windows on it. But you can install several versions of the Linux operating system that look and feel very much like Windows. If you want to, you can use the Raspberry Pi to surf the internet, send an email or write a letter using a word processor. But you can also do so much more. Easy to use but powerful, affordable and (as long as you're careful) difficult to break, the Raspberry Pi is the perfect tool for aspiring computer scientists.

The Raspberry Pi is one of computing's modern marvels-a credit-card-sized single board computer, capable of running Linux, its applications, and capable of handling playback of HD video. Launched on February 29, 2012, it has now been released in three different versions, with the current two versions being the Model A (256 Mbyte with USB) and the Model B (512 Mbyte, with 2 x USB and Ethernet).

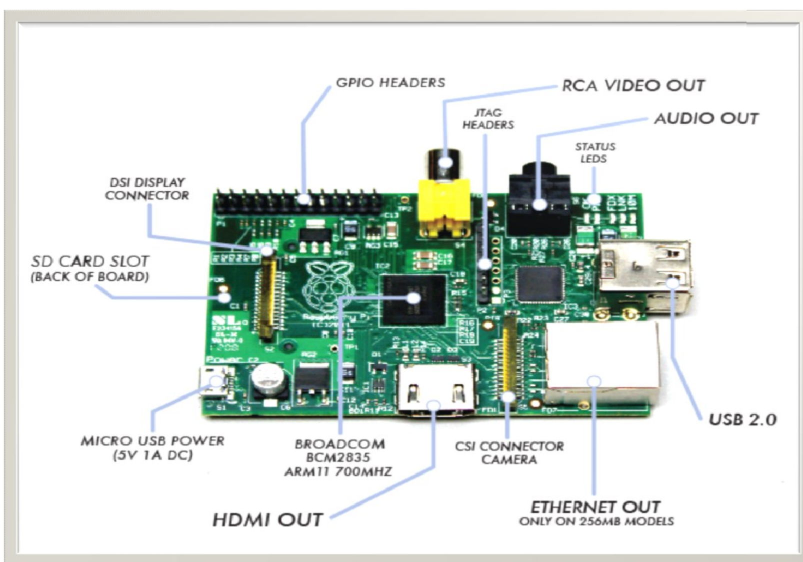

Fig.2.1: The Raspberry Pi Kit

One of the great things about the Raspberry Pi is that there's no single way to use it. Whether you just want to watch videos and surf the web, or you want to hack, learn, and make with the board, the Raspberry Pi is a flexible platform for fun, utility, and experimentation.

2.2. Different ways of using Raspberry Pi

The different ways of using a Raspberry Pi are given as follows:

2.2.1. General Purpose Computing

The Raspberry Pi is a computer and it can in fact be used as one. After you get it up and running you can choose to have it boot into a graphical desktop environment with a web browser, which is a lot of what we use computers for these days. Going beyond the web, you can install a wide variety of free software, such as the Libre Office productivity suite for working with documents and spreadsheets when you don't have an Internet connection.

2.2.2. Learning to program

Since the Raspberry Pi is meant as an educational tool to encourage kids to experiment with computers, it comes preloaded with interpreters and compilers for many different programming languages. For the beginner, there's Scratch, a graphical programming language from MIT. If you're eager to jump into writing code, the Python programming language is a great way to get started. You can write programs for your Raspberry Pi in many different programming languages like C, Ruby, Java, and Perl.

2.2.3. Project Platform

The Raspberry Pi differentiates itself from a regular computer not only in its price and size, but also because of its ability to integrate with electronics projects.

2.2.4. Media Center

Since the Raspberry Pi has both HDMI and composite video outputs, it's easy to connect to televisions. It also has enough processing power to play full screen video in high definition. To leverage these capabilities, contributors to the free and open source media player, XBMC, have ported their project to the Raspberry Pi. XBMC can play many different media formats and its interface is designed with large buttons and text so that it can be easily controlled from the couch. XBMC makes the Raspberry Pi a fully customizable home entertainment center component.

2.2.5 "Bare Metal" Computer Hacking

Most people who write computer programs write code that runs within an operating system, such as Windows, Mac OS, or—in the case of Raspberry Pi—Linux. But what if you could write code that runs directly on the processor without the need for an operating system? You could even write your own operating system from scratch if you were so inclined.

2.3. Blocks of Raspberry Pi

All the parts of the Raspberry Pi can be described as below:

2.3.1. The processor

At the heart of the Raspberry Pi is the same processor you would have found in the iPhone 3G and the Kindle 2, so you can think of the capabilities of the Raspberry Pi as comparable to those powerful little devices. This chip is a 32 bit, 700 MHz System on a Chip, which is built on the ARM11 architecture. ARM chips come in a variety of architectures with different cores configured to provide different capabilities at different price points. The Model B has 512MB of RAM and the Model A has 256 MB.

2.3.2. The secure digital (SD) card slot

There’s no hard drive on the Pi; everything is stored on an SD Card. One reason you’ll want some sort of protective case sooner than later is that the solder joints on the SD socket may fail if the SD card is accidentally bent.

2.3.3. The USB Port

On the Model B there are two USB 2.0 ports, but only one on the Model A. Some of the early Raspberry Pi boards were limited in the amount of current that they could provide. Some USB devices can draw up 500mA. The original Pi board supported 100mA or so, but the newer revisions are up to the full USB 2.0 spec. One way to check your board is to see if you have two polyfuses limiting the current. In any case, it is probably not a good idea to charge your cell phone with the Pi. You can use a powered external hub if you have a peripheral that needs more power.

2.3.4. Ethernet Port

The model B has a standard RJ45 Ethernet port. The Model A does not, but can be connected to a wired network by a USB Ethernet adapter (the port on the Model B is actually an onboard USB to Ethernet adapter). WiFi connectivity via a USB dongle is another option.

2.3.5. HDMI Connector

The HDMI port provides digital video and audio output. 14 different video resolutions are supported, and the HDMI signal can be converted to DVI (used by many monitors), composite (analog video signal usually carried over a yellow RCA connector), or SCART (a European standard for connecting audio-visual equipment) with external adapters.

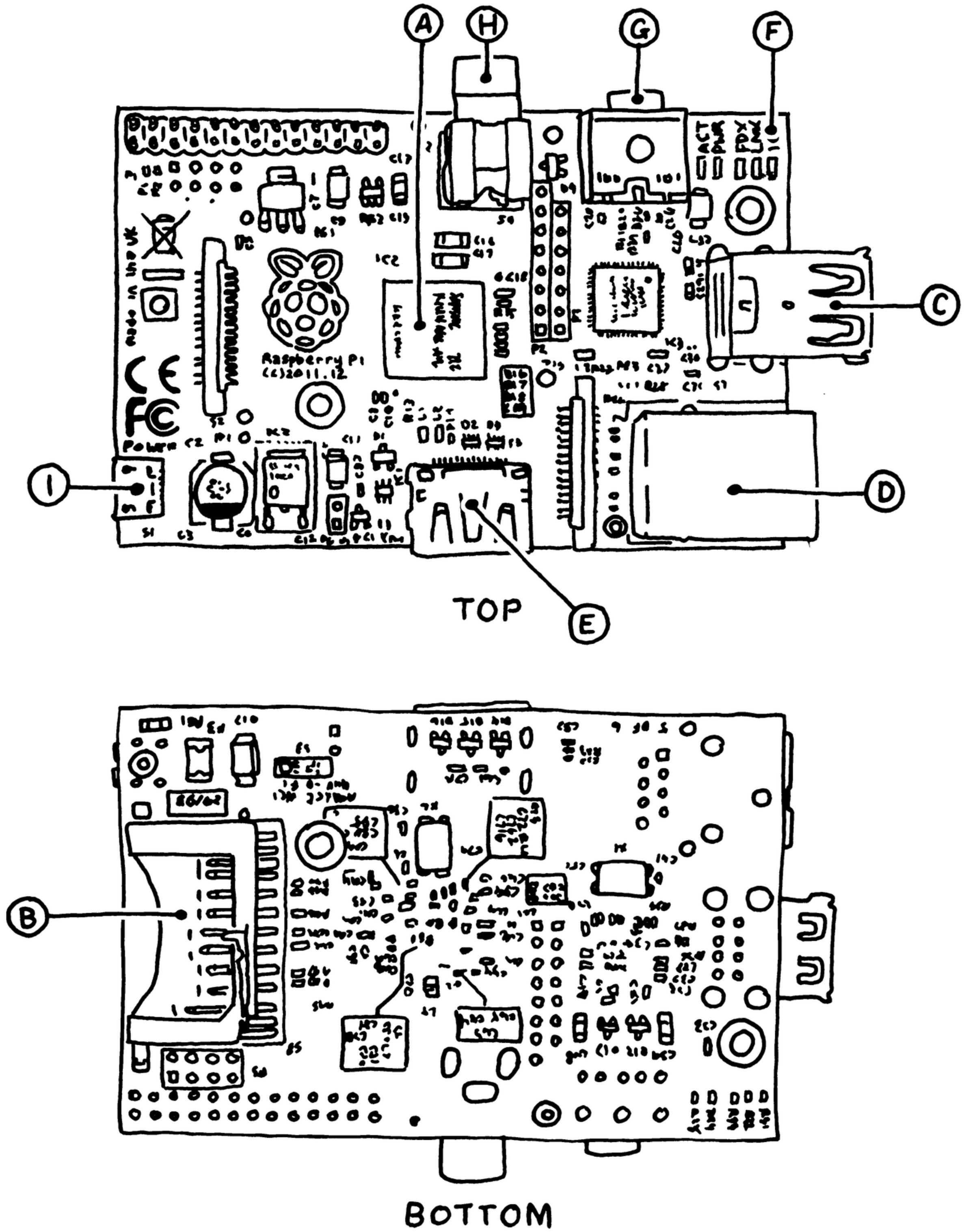

Fig.2.2: A Map of the Hardware Interface Of the Raspberry Pi

2.3.6. Status LEDs

The Pi has five indicator LEDs that provide visual feedback.

Table 2.1: The Five status LED’s

ACT	Green	Lights when the SD card is accessed (marked OK on earlier boards)
PWR	Red	Hooked up to 3.3V power
FDX	Green	On if network adapter is full duplex
LNK	Green	Network activity light
100	Yellow	On if the network connection is 100Mbps (some early boards have a 10M misprint)

2.3.7. Analog Audio Output

This is a standard 3.5mm mini analog audio jack, intended to drive high impedance loads (like amplified speakers). Headphones or unpowered speakers won’t sound very good; in fact, as of this writing the quality of the analog output is much less than the HDMI audio output you’d get by connecting to a TV over HDMI. Some of this has to do with the audio driver software, which is still evolving.

2.3.8. Composite Video Out

This is a standard RCA-type jack that provides composite NTSC or PAL video signals. This video format is extremely low-resolution compared to HDMI. If you have a HDMI television or monitor, use it rather than a composite television.

2.3.9. Power Input

On of the first things you’ll realize is that there is no power switch on the Pi. This microUSB connector is used to supply power (this isn’t an additional USB port; it’s only for power). MicroUSB was selected because the connector is cheap USB power supplies are easy to find.

2.4. Peripherals of Raspberry Pi

There are a bunch of pre-packaged starter kits that have well-vetted parts lists; there are a few caveats when fitting out your Raspberry Pi. An Ethernet cable, a powered USB 2.0 Hub, heat sinks, real time clock, camera module, LCD display, Wi-Fi Dongle, and a laptop dock are required.

2.4.1. Power supply

This is the most important peripheral to get right and a microUSB adapter that can provide 5V and at least 700mA of current (500mA for the Model A) should be used. A cell phone charger won’t cut it, even if it has the correct connector. A typical cell phone charger only provides 400mA of current or less, but check the rating marked on the back. An underpowered Pi may still seem to work but will be flaky and may fail unpredictably. With the current version of the Pi board, it is possible to power the Pi from a USB hub that feeds power. However, there isn’t much protection circuitry so it may not be the best idea to power it over the USB ports. This is especially true if you’re going to be doing electronics prototyping where you may accidentally create shorts that may draw a lot of current.

2.4.2. SD card

At least 4GB SD Card should be used, and it should be a Class 4 card. Class 4 cards are capable of transferring at least 4MB/sec. Some of the earlier Raspberry Pi boards had problems with Class 6 or higher cards, which are capable of faster speeds but are less stable. A microSD card in an adapter is perfectly usable as well.

2.4.3. HDMI Cable

If you’re connecting to a monitor you’ll need this, or an appropriate adapter for a DVI monitor. You can also run the Pi headless. HDMI cables can vary wildly in price.

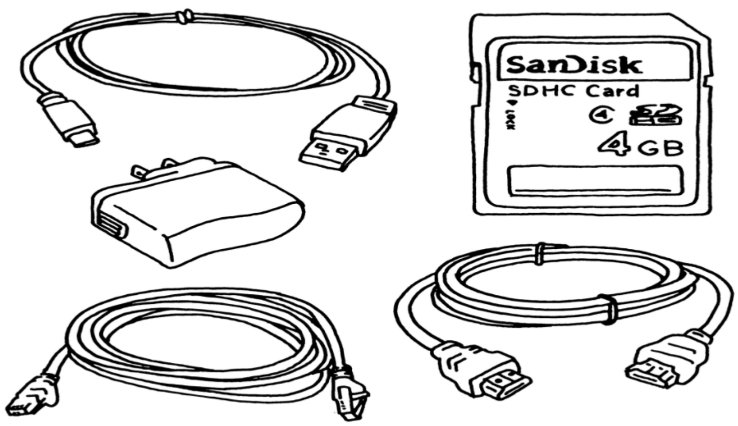

Fig.2.3: The Basic peripherals

2.5. Installing Linux on the Raspberry Pi

The majority of modern Linux distributions are user-friendly, with a graphical user interface (GUI) that provides an easy way to perform common tasks. It is, however, quite different to both Windows and OS X, so if you’re going to get the most out of your Raspberry Pi, you’ll need a quick primer in using the operating system.

“The Raspberry Pi”, Linux is an open-source project which was originally founded to produce a kernel that would be free for anyone to use. The kernel is the heart of an operating system, and handles the communication between the user and the hardware.Although only the kernel itself is rightly called Linux, the term is often used to refer to a collection of different open-source projects from a variety of companies. These collections come together to form different flavours of Linux, known as distributions.

The original version of Linux was combined with a collection of tools created by a group called GNU. The resulting system, known as GNU/Linux, was basic but powerful. Unlike other operating systems of the era, it offered facilities like multiple user accounts where several users can share a single computer. That’s something rival closed-source operating systems have taken on board, with both Windows and OS X now supporting multiple user accounts on the same system. It’s also still present in Linux, and provides security and protection for the operating system.

In Linux, you’ll spend most of your time running a restricted user account. This doesn’t mean you’re being limited in what you can do. Instead, it prevents you from accidentally doing something that will break the software on your Raspberry Pi. It also prevents viruses and other malware from infecting the system by locking down access to critical system files and directories.

2.5.1. Using the Command Line

Before you start, open up the LXTerminal program. There are two tricks that make life much easier in the shell: *auto complete* and *command history*. Often you will only need to type the first few characters of a command or filename, then hit tab. The shell will attempt to auto complete the string based on the files in the current directory or programs in commonly used directories (the shell will search for executable programs in places like /bin or /usr/bin/). If you hit the up arrow on the command line you’ll be able to step back through your command history, which is useful if you mistyped a character in a long string of commands.

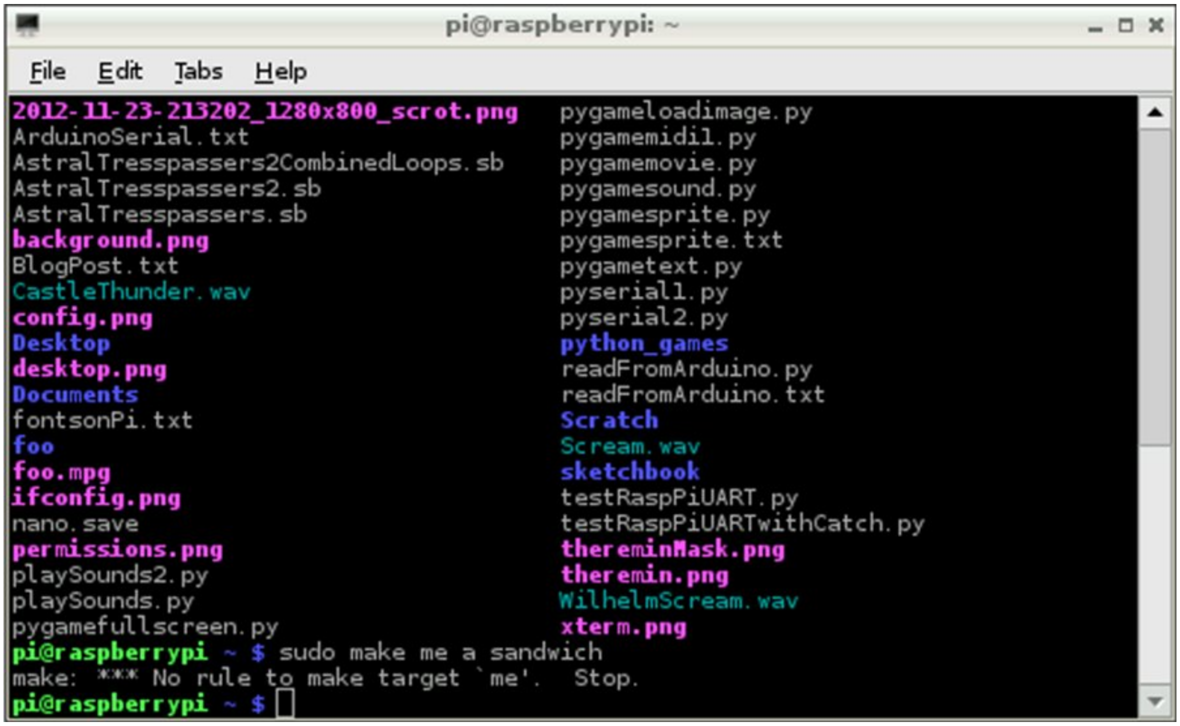

Fig.2.4: LXTerminal Program

Some of the most important directories in the Raspbian filesystem are shown below:

Table 2.2: Directories of Raspbian filesystem

Directory	**Description**
/bin	Programs and commands that all users can run
/boot	All the files needed at boot time
/dev	Special files that represent the devices on your system
/etc	Configuration files
/etc/init.d	Scripts to start up services
/etc/X11	X11 configuration files
/home	User home directories

/home/pi	Home directory for pi user
/lib	Kernel modules/drivers
/media	Mount points for removable media
/proc	A virtual directory with information about running processes and the OS
/sbin	Programs for system maintenance

2.5.2. Installation

Installing VNC server on Pi allows you to see your Raspberry Pi's desktop remotely in a graphical way, using the mouse as if you were sitting in front of your Pi. It also means you can put your Pi somewhere else on the network, but still control it. Also, internet can be shared from laptop's WiFi over Ethernet. This helps in accessing internet on Raspberry Pi.

Step 1: Setting up your Raspberry Pi

After getting Raspberry Pi you need SD Card which has desired OS. You will find lots of blogs and links about making SD card for Raspberry Pi. You can follow any of them to make your own SD Card, but if you want, you can check out this link. This has very good start up guide for Raspberry Pi.

As you are ready with your SD Card insert it into Raspberry Pi. Attach Micro USB Power Cable with it. Also attaché your Raspberry Pi with your Laptop via Ethernet Cable. Connect Keyboard & Mouse with it. Also connect HDMI Display. Now power on your Pi.

Step 2: Sharing Internet over Ethernet

For sharing internet for multiple users over Ethernet, go to Network and Sharing Center. Click on the WiFi network

Click on Properties, then go to Sharing and click on Allow other network users to connect. Make sure that networking connection is changed to Local Area Connection.

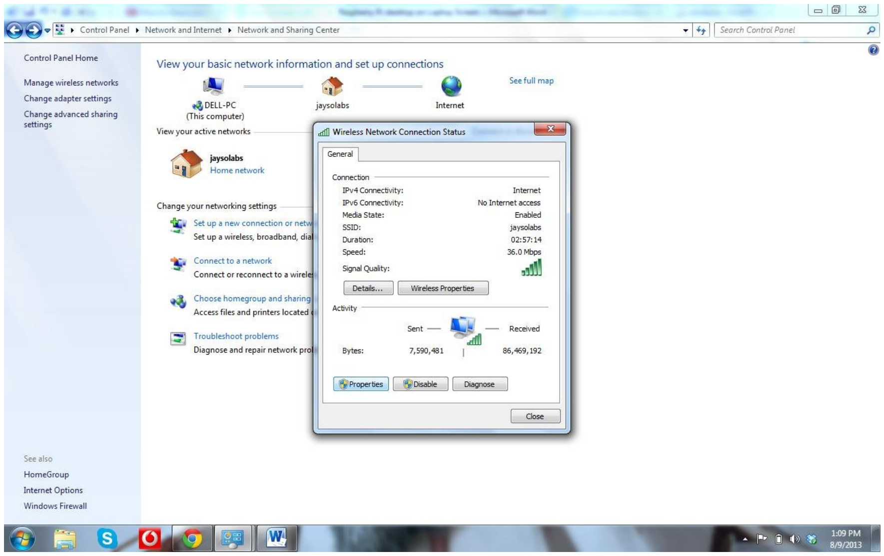

Fig.2.5: Windows showing local area connection

The IP assigned to your laptop is 192.168.137.1

Step 3: For Checking the IP assigned to the connected Ethernet Device

Consider that IP assigned to your Laptop is 192.168.137.1 and subnet mask is 255.255.255.0

- Open command prompt.
- Ping on broadcast address of your IP i.e. ping 192.168.137.255
- Stop the ping after 5 seconds.
- Watch device replies : arp –a

HDMI Display: Now you should install VNC server in Raspberry Pi. For that if you have HDMI display and Raspbian OS running on it, open LX-Terminal and type following commands to install VNC.

$ sudo apt-get update

$ sudo apt-get install tightvncserver

Don’t have Display : If you do not arrange display even for one time setup than also no need to worry you can install Putty as per your windows configuration and via SSH you can connect with your Raspberry PI. As you will get access of your Pi terminal run following command to install VNC.

$ sudo apt-get update

$ sudo apt-get install tightvncserver

Start VNC Server on Pi:For starting VNC, enter the following command in SSH terminal,

$ vncserver :1

You will be prompted to enter and confirm a password. This will be asked only once, during one time setup. Enter an 8 digit password. Note that this is the password that you will need to use to connect to the Raspberry Pi remotely.

You will also be asked if you want to create a separate "read-only" password – say no (n).

The VNC server is now running on your Pi and so we can attempt to connect to it, but first we must switch to the computer from which we want to control the Pi and setup a VNC client to connect to the Pi.

Step 4: Client Side (Laptop)

Download VNC client from http://www.realvnc.com/download/vnc/ and install it. When you first run VNC Viewer, you will see following:

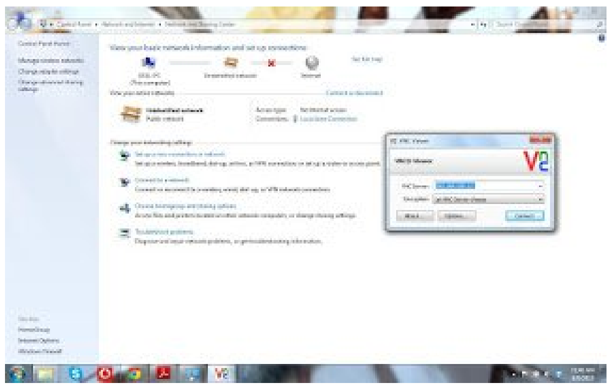

Fig.2.6: VNC Viewer

Enter IP address of your Raspberry Pi given dynamically by your laptop and append with: 1 (denoting port number) and press connect. You will get a warning message, press 'Continue'.

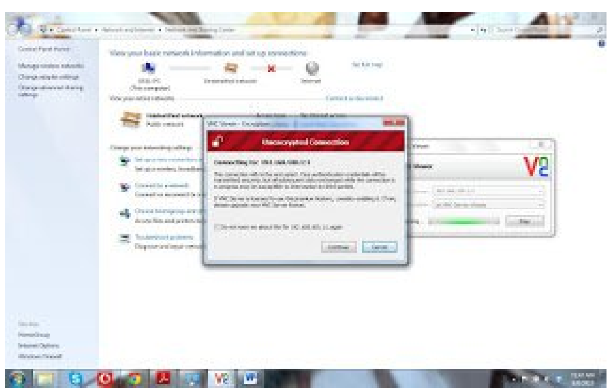

Fig.2.7: Warning message shown

Enter the 8 digit password which was entered in VNC server installation on Raspberry Pi.

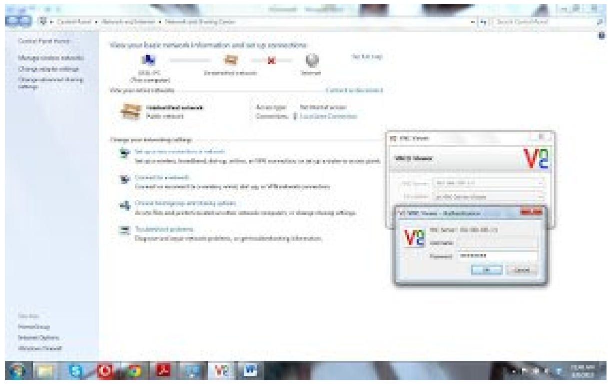

Fig.2.8: Enter password

Finally, the VNC window itself should appear. You will be able to use the mouse and do everything as if you were using the Pi's keyboard mouse and monitor, except through your other computer. As with SSH, since this is working over your network, your Pi could be situated anywhere, as long as it is connected to your network.

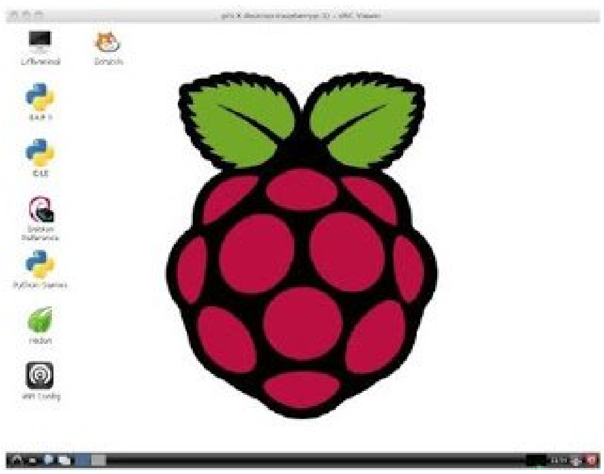

Fig.2.9: VNC window

Step 5: Running VNC server at start-up in Raspberry Pi

Connecting to your Raspberry Pi remotely with VNC is fine as long as your Pi does not reboot. If it does, then you either have to connect with SSH and restart the VNC Server or arrange for the VNC Server to run automatically after the Raspberry Pi reboots. To ensure that VNC starts automatically, run following commands on terminal.

Open ".config" folder from Pi user folder. (It is hidden folder)

```
$ cd /home/pi
```

```
$ cd .config
```

Create folder called "autostart" in it. Also create file called "tightvnc.desktop" in that folder. To create file you can use any known text editor. Here I use gnome-text-editor for this.

$ mkdir autostart

$ cd autostart

$ gnome tightvnc.desktop

Edit the contents of file with following text and save the file.

[Desktop Entry]

Type=Application

Name=TightVNC

Exec=vncserver :1

StartupNotify=false

2.6. Voice Recognition Software

Voice Recognition can be achieved in various ways. One of the easiest ways to achieve this is by using Google API. The software being described here uses Google Voice and speech APIs. The voice command from the user is captured by the microphone. This is then converted to text by using Google voice API. The text is then compared with the other previously defined commands inside the commands configuration file. If it matches with any of them, then the bash command associated with it will be executed. You can also use this system as an interactive voice response system by making the raspberry pi respond to your commands via speech. This is be achieved by using the Google speech API, which converts the text into speech. It basically converts our spoken question into to text, process the query and return the answer, and finally turn the answer from text to speech. This is divided into four parts:

1. Speech to Text
2. Query Processing
3. Text to Speech
4. Combining them Together

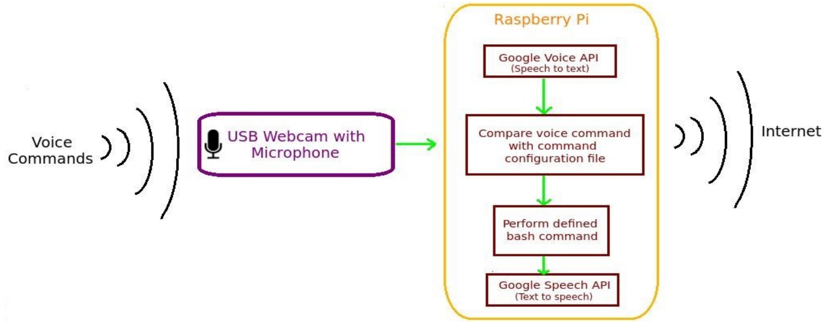

Fig.2.10: Voice Recognition Software for Raspberry Pi

The Hardware components required are:

1. Raspberry Pi Board
2. An SD Card with Pre-Installed Operating System
3. A USB Microphone
4. A Wi-Fi Dongle or an Ethernet Cable.

2.6.1. Speech to Text

Speech recognition can be achieved in many ways on Linux (so on the Raspberry Pi), The easiest way is to use Google voice recognition API. as the accuracy is very good. To ensure recording is setup, ffmpeg must be installed:

```
sudo apt-get install ffmpeg
```

To use the Google's voice recognition API, I use the following bash script. Copy the following text and save it as '*speech2text.sh*'

```
#!/bin/bash

echo "Recording... Press Ctrl+C to Stop."

arecord -D "plughw:1,0" -q -f cd -t wav | ffmpeg -loglevel panic -y -i - -ar 16000 -acodec flac file.flac  >
/dev/null 2>&1

echo "Processing..."

wget -q -U "Mozilla/5.0" --post-file file.flac --header "Content-Type: audio/x-flac; rate=16000" -O -
"http://www.google.com/speech-api/v1/recognize?lang=en-us&client=chromium" | cut -d\" -f12  >stt.txt

echo -n "You Said: "

cat stt.txt

rm file.flac  > /dev/null 2>&1
```

As soon as it is executed, it starts recording and save the audio in a flac file. The Recording can be stopped by pressing CTRL+C. The audio file is then sent to Google for conversion and text will be returned and saved in a file called "stt.txt". And the audio file will be deleted.

And to make it executable.

```
chmod +x speech2text.sh
```

To run it

```
./speech2text.sh
```

2.6.2. Query Processing

Processing the query works similar to searching a question in Google, but in this scenario only one answer must be returned. Wolfram Alpha seems to be a good choice here. It is a Python interface library. The API allows clients to submit free-form queries similar to the queries one might enter at the Wolfram Alpha website, and for the computed results to be returned in a variety of formats. The API is implemented in a standard REST protocol using HTTP GET requests. Each result is returned as a descriptive XML structure wrapping the requested content format.

2.6.2.1. Installing Wolframalpha Python Library

Download package from https://pypi.python.org/pypi/wolframalpha, unzip it somewhere. And then you need to install setuptool and build the setup.

```
apt-get install python-setuptools easy_install pip
sudo python setup.py build
```

And finally run the setup.

```
sudo python setup.py
```

2.6.2.2. Getting the APP_ID

To get a unique Wolfram Alpha AppID, signup at *products.wolframalpha.com/api/* for a Wolfram Alpha Application ID.

You should now be signed in to the Wolfram Alpha Developer Portal and, on the My Apps tab, click the “Get an AppID” button and fill out the “Get a New AppID” form. Use any Application name and description you like. Click the “Get AppID” button.

2.6.2.3.Wolfram Alpha Python Interface

Save this Python script as “*queryprocess.py*”.

```
print "Sorry, I am not sure."
```

```
#!/usr/bin/python

    import wolframalpha
    import sys

    # Get a free API key here http://products.wolframalpha.com/api/
    # This is a fake ID, go and get your own, instructions on my blog.
    app_id='HYO4TL-A9QOUALOPX'

    client = wolframalpha.Client(app_id)

    query = ' '.join(sys.argv[1:])
    res = client.query(query)

    if len(res.pods) > 0:
        texts = ""

                pod = res.pods[1]
        if pod.text:
            texts = pod.text
        else:
            texts = "I have no answer for that"
        # to skip ascii character in case of error
        texts = texts.encode('ascii', 'ignore')
        print texts
    else:
```

2.6.3. Text To Speech

From the processed query, we are returned with an answer in text format. What we need to do now is turning the text to audio speech. There are a few options available like Cepstral or Festival, but Google's speech service is chosen due to its excellent quality. First of all, to play audio we need to install mplayer:

```
sudo apt-get install mplayer
```

We have this simple bash script. It downloads the MP3 file via the URL and plays it. Copy and name it as "*text2speech.sh*":

```
#!/bin/bash

say() { local IFS=+;/usr/bin/mplayer -ao alsa -really-quiet -noconsolecontrols
"http://translate.google.com/translate_tts?tl=en&q=$*"; }

say $*
```

And to make it executable.

```
chmod +x text2speech.sh
```

To test it, you can try

```
./text2speech.sh "My name is Oscar and I am testing the audio."
```

2.6.3.1. Google Text To Speech Text Length Limitation

Although, Google Text to Speech is a great service, there is a limit on the length of the message of about 100 characters.

To work around this, here is an upgraded bash script that breaks up the text into multiple parts so each part is no longer than 100 characters, and each parts can be played successfully. The modified script can be seen as below.

```
#!/bin/bash


INPUT=$*

STRINGNUM=0

ary=($INPUT)

for key in "${!ary[@]}"

do

SHORTTMP[$STRINGNUM]="${SHORTTMP[$STRINGNUM]} ${ary[$key]}"

LENGTH=$(echo ${#SHORTTMP[$STRINGNUM]})

if [[ "$LENGTH" -lt "100" ]]; then

SHORT[$STRINGNUM]=${SHORTTMP[$STRINGNUM]}
```

```
else

STRINGNUM=$(($STRINGNUM+1))

SHORTTMP[$STRINGNUM]="${ary[$key]}"

SHORT[$STRINGNUM]="${ary[$key]}"

fi

done

for key in "${!SHORT[@]}"

do

say() { local IFS=+;/usr/bin/mplayer -ao alsa -really-quiet -noconsolecontrols
"http://translate.google.com/translate_tts?tl=en&q=${SHORT[$key]}"; }


say $*

done
```

2.6.4. Putting It Together

For all of these scripts to work together, we have to call them in an another script and "*main.sh*".

```
#!/bin/bash
echo "Recording... Press Ctrl+C to Stop."
./speech2text.sh
QUESTION=$(cat stt.txt)
echo "Me: ", $QUESTION

ANSWER=$(python queryprocess.py $QUESTION)
echo "Robot: ", $ANSWER
./text2speech.sh $ANSWER
```

To make *main.s*h executable, run it

```
chmod +x text2speech.sh
./main.sh
```

This idea of combining the Speech recognition ability on the Raspberry Pi with the powerful digital/analog I/O hardware, to build a useful voice control system, can be adopted in Robotics and Home Automation.