CHAPTER-1

INTRODUCTION

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.

1.1.1Importance 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 labor 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.

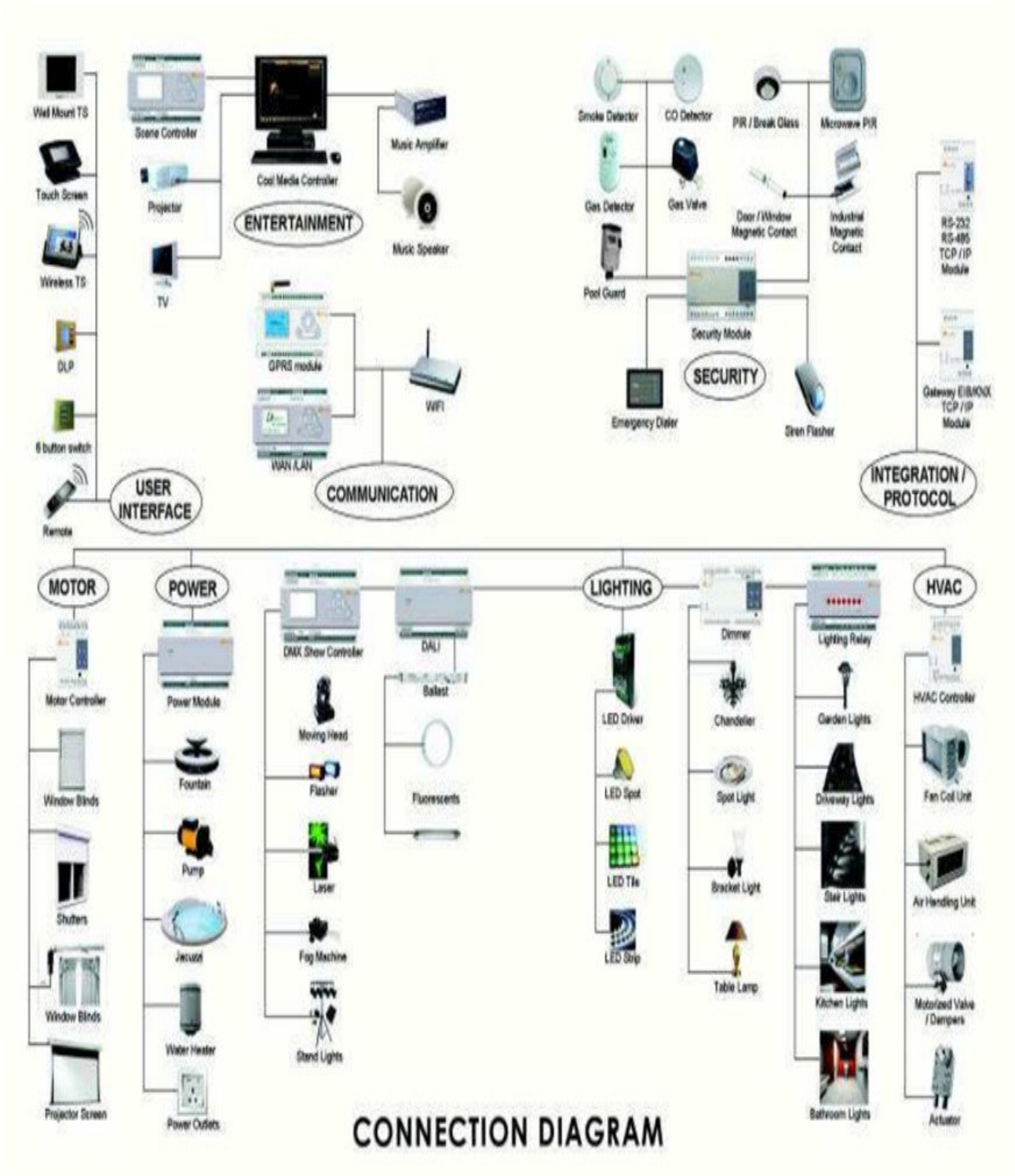

Fig1.1 Connection diagram

1.1.2System Elements

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.

Automatic control of blinds and curtains can be used for:

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

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.

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.

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.

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.

What our project aims at?

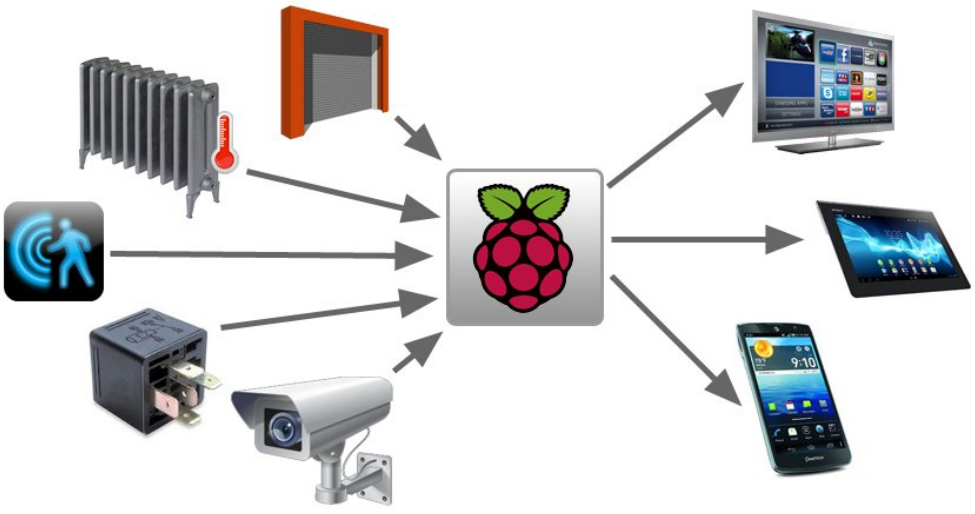

Fig1.2 Raspberry Pi interface with devices

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.

Fig1.3 Raspberry Pi model B+ kit

Fig1.4 Control of Home appliances with phone using RPi

CHAPTER 2

RASPBERRY PI AND ITS FUNCTIONALITY

2.1 What is Raspberry Pi?

The Raspberry Pi is a series of credit card-sized single-board computers developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools.

The original Raspberry Pi and Raspberry Pi 2 are manufactured in several board configurations through licensed manufacturing agreements with Newark element14 (Premier Farnell), RS Components and Egoman. These companies sell the Raspberry Pi online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks. The hardware is the same across all manufacturers.

The original Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SoC),which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded (models B and B+) to 512 MB. The system has Secure Digital (SD) (models A and B) or Micro SD (models A+ and B+) sockets for boot media and persistent storage.

In 2014, the Raspberry Pi Foundation launched the *Compute Module*, which packages a BCM2835 with 512 MB RAM and an eMMC flash chip into a module for use as a part of embedded systems.

The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, C++, Java, Perl and Ruby.

As of 18 February 2015, over five million Raspberry Pis have been sold. While already the fastest selling British personal computer, it has also shipped the second largest number of units behind the Amstrad PCW, the "Personal Computer Word-processor", which sold eight million.

In early February 2015, the next-generation Raspberry Pi, Raspberry Pi 2, was officially announced. The new computer board will initially be available only in one configuration (model B) and features a Broadcom BCM2836 SoC, with a quad-core ARM Cortex-A7 CPU and a Video Core IV dual-core GPU; 1 GB of RAM with remaining specifications being similar to those of the previous generation model B+. Crucially, the Raspberry Pi 2 will retain the same US$35 price point of the model B, with the US$25 model A remaining on sale.

2.2 Components of Raspberry Pi

A) HARDWARE

In the above block diagram for model *A, B, A+, B+*; model *A* and *A+* are the lowest two blocks and the rightmost block are missing (note that these three blocks are in a chip that actually contains a three-port USB hub, with a USB Ethernet adapter connected to one of its ports). In model *A* and *A+* the USB port is connected directly to the SoC. On model *B+* the chip contains a five point hub, with four USB ports fed out, instead of the two on model *B*.

Processor

The SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in older smartphones (such as iPhone / 3G / 3GS). The Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SoC), which includes an 700 MHz ARM1176JZF-S processor, Video Core IV GPU, and RAM. It has a Level 2 cache of 128 KB, used primarily by the GPU, not the CPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

While operating at 700 MHz by default, the first generation Raspberry Pi provided a real world performance roughly equivalent to 0.041 GFLOPS. On the CPU level the performance is similar to a 300 MHz Pentium II of 1997-1999. The GPU provides 1 Gpixel/s or 1.5 Gtexel/s of graphics processing or 24 GFLOPS of general purpose computing performance. The graphics capabilities of the Raspberry Pi are roughly equivalent to the level of performance of the Xbox of 2001.

The LINPACK single node compute benchmark results in a mean single precision performance of 0.065 GFLOPS and a mean double precision performance of 0.041 GFLOPS for one Raspberry Pi Model-B board. A cluster of 64 Raspberry Pi Model-B computers, labeled "Iridis-pi", achieved a LINPACK HPL suite result of 1.14 GFLOPS (n=10240) at 216 watts for c. US$4,000.

The first generation Raspberry Pi chip operated at 700 MHz by default and did not become hot enough to need a heat sink or special cooling, unless the chip was overclocked. The second generation runs on 900 MHz by default, and also does not become hot enough to need a heat sink or special cooling, again overclocking may heat up the SoC more than usual.

Most Raspberry Pi chips could be overclocked to 800 MHz and some even higher to 1000 MHz There are reports the second generation can be similarly overclocked, in extreme cases, even to 1500 MHz (discarding all safety features and over voltage limitations). In the Raspbian Linux distro the overclocking options on boot can be done by a software command running "sudo raspi-config" without voiding the warranty, see note 9 below. In those cases the Pi automatically shuts the overclocking down in case the chip reaches 85 °C (185 °F), but it is possible to overrule automatic over voltage and overclocking settings (voiding the warranty). In that case, one can try putting an appropriately sized heat sink on it to keep the chip from heating up far above 85 °C.

Newer versions of the firmware contain the option to choose between five overclock ("turbo") presets that when turned on try to get the most performance out of the SoC without impairing the lifetime of the Pi. This is done by monitoring the core temperature of the chip, and the CPU load, and dynamically adjusting clock speeds and the core voltage. When the demand is low on the CPU, or it is running too hot, the performance is throttled, but if the CPU has much to do, and the chip's temperature is acceptable, performance is temporarily increased, with clock speeds of up to 1 GHz, depending on the individual board, and on which of the turbo settings is used. The five settings are:

none; 700 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolt,

modest; 800 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolt,

medium; 900 MHz ARM, 250 MHz core, 450 MHz SDRAM, 2 overvolt,

high; 950 MHz ARM, 250 MHz core, 450 MHz SDRAM, 6 overvolt,

turbo; 1000 MHz ARM, 500 MHz core, 600 MHz SDRAM, 6 overvolt.

In the highest (*turbo*) preset the SDRAM clock was originally 500 MHz, but this was later changed to 600 MHz because 500 MHz sometimes causes SD card corruption. Simultaneously in *high* mode the core clock speed was lowered from 450 to 250 MHz, and in *medium* mode from 333 to 250 MHz

RAM

On the older beta model B boards, 128 MB was allocated by default to the GPU, leaving 128 MB for the CPU. On the first 256 MB release model B (and model A), three different splits were possible. The default split was 192 MB (RAM for CPU), which should be sufficient for standalone 1080p video decoding, or for simple 3D, but probably not for both together. 224 MB was for Linux only, with just a 1080p framebuffer, and was likely to fail for any video or 3D. 128 MB was for heavy 3D, possibly also with video decoding (e.g. XBMC). Comparatively the Nokia 701 uses 128 MB for the Broadcom Video Core IV. For the new model B with 512 MB RAM initially there were new standard memory split files released(arm256_start.elf, arm384_start.elf, arm496_start.elf) for 256 MB, 384 MB and 496 MB CPU RAM (and 256 MB, 128 MB and 16 MB video RAM). But a week or so later the RPF released a new version of start. elf that could read a new entry in config.txt (gpu_mem=xx) and could dynamically assign an amount of RAM (from 16 to 256 MB in 8 MB steps) to the GPU, so the older method of memory splits became obsolete, and a single start.elf worked the same for 256 and 512 MB Pis. The second generation has 1 GB of RAM.

- Networking

Though the model A and A+ do not have an 8P8C ("RJ45") Ethernet port, they can be connected to a network using an external user-supplied USB Ethernet or Wi-Fi adapter. On the model B and B+ the Ethernet port is provided by a built-in USB Ethernet adapter.

- Peripherals

  Generic USB keyboards and mice are compatible with the Raspberry Pi.

- Video

  The video controller is capable of standard modern TV resolutions, such as HD and Full HD, and higher or lower monitor resolutions and older standard CRT TV resolutions; capable of the following: 640×350 EGA; 640×480 VGA; 800×600 SVGA; 1024×768 XGA; 1280×720 720p HDTV; 1280×768 WXGA variant; 1280×800 WXGA variant; 1280×1024 SXGA; 1366×768 WXGA variant; 1400×1050 SXGA+; 1600×1200 UXGA; 1680×1050 WXGA+; 1920×1080 1080p HDTV; 1920×1200 WUXGA. It can generate 576i and 480i composite video signals for PAL-BGHID, PAL-M, PAL-N, NTSC and NTSC-J.

  Real-time clock

  The Raspberry Pi does not come with a real-time clock, which means it cannot keep track of the time of day while it is not powered on.

  As alternatives, a program running on the Pi can get the time from a network time server or user input at boot time.

  A real-time clock (such as the DS1307) with battery backup can be added (often via the I²C interface).

  B) SOFTWARES

  The Raspberry Pi primarily uses Linux-kernel-based operating systems.

  The ARM11 chip at the heart of the Pi (pre-Pi 2) is based on version 6 of the ARM. The current releases of several popular versions of Linux, including Ubuntu, will not run on the ARM11. It is not possible to run Windows on the original Raspberry Pi, though the new Raspberry Pi 2 will be able to run Windows 10. The Raspberry Pi 2 currently only supports Ubuntu Snappy Core and Raspbian.

  The install manager for the Raspberry Pi is NOOBS. The operating systems included with NOOBS are:

- Archlinux ARM
- OpenELECPidora (Fedora Remix)
- Puppy Linux
- Raspbmc and the XBMC open source digital media center
- RISC OS– The operating system of the first ARM-based computer
- Raspbian (recommended for Raspberry Pi 1) – Maintained independently of the Foundation; based on the ARM hard-float(armhf) Debian 7 'Wheezy' architecture port originally designed for ARMv7

and later processors (with Jazelle RCT/ThumbEE, VFPv3, and NEON SIMD extensions), compiled for the more limited ARMv6 instruction set of the Raspberry Pi. A minimum size of 4 GB SD card is required. There is a Pi Store for exchanging programs

The Raspbian Server Edition is a stripped version with fewer software packages bundled as compared to the usual desktop computer oriented Raspbian.

The Wayland display server protocol enable the efficient use of the GPU for hardware accelerated GUI drawing functions. on 16 April 2014 a GUI shell for Weston called Maynard was released.

- PiBang Linux is derived from Raspbian.
- Raspbian for Robots - A fork of Raspbian for robotics projects with LEGO, Grove, and Arduino.
- Xbian using the Kodi(formerly XBMC) open source digital media center

- Raspberry Pi Fedora Remix
- Slackware ARM – Version 13.37 and later runs on the Raspberry Pi without modification. The 128–496 MB of available memory on the Raspberry Pi is at least twice the minimum requirement of 64 MB needed to run Slackware Linux on an ARM or i386 system. (Whereas the majority of Linux systems boot into a graphical user interface, Slackware's default user environment is the textual shell .The Fluxbox window manager running under the X Window System requires an additional 48 MB of RAM.
- FreeBSDand NetBSD
- Plan 9 from Bell Labs and Inferno (in beta)
- Moebius – A light ARM HF distribution based on Debian. It uses Raspbian repository, but it fits in a 128 MB SD card. It has just minimal services and its memory usage is optimized to keep a small footprint.
- OpenWrt – Primarily used on embedded devices to route network traffic.
- Kali Linux – A Debian-derived distro designed for digital forensics and penetration testing.
- Instant WebKiosk – An operating system for digital signage purposes (web and media views)
- Ark-OS– Website and email self-hosting
- Minepion – Dedicated operating system for mining cryptocurrency
- Kano OS http://kano.me/downloads
- Nard SDK For industrial embedded systems

CHAPTER 3

VOICE RECOGNITION

Voice or speech recognition is the ability of a machine or program to receive and interpret dictation, or to understand and carry out spoken commands.

The field of computer science that deals with designing computer systems that can recognize spoken words. Note that voice recognition implies only that the computer can take dictation, not that it understands what is being said. Comprehending human languages falls under a different field of computer science called processing.

A number of voice recognition systems are available on the market. The most powerful can recognize thousands of words. However, they generally require an extended training session during which the computer system becomes accustomed to a particular voice and accent. Such systems are said to be speaker dependent.

Many systems also require that the speaker speak slowly and distinctly and separate each word with a short pause. These systems are called discrete speech systems. Recently, great strides have been made in continuous speech systems -- voice recognition systems that allow you to speak naturally. There are now several continuous-speech systems available for personal computers.

Because of their limitations and high cost, voice recognition systems have traditionally been used only in a few specialized situations. For example, such systems are useful in instances when the user is unable to use a keyboard to enter data because his or her hands are occupied or disabled. Instead of typing commands, the user can simply speak into a headset. Increasingly, however, as the cost decreases and performance improves, speech recognition systems are entering the mainstream and are being used as an alternative to keyboards.

3.1 POCKETSPHINX

Pocket Sphinx is a lightweight speech recognition engine. A version of Sphinx that can be used in embedded systems like those based on an ARM processor. Incorporates features such as fixed-point arithmetic and efficient algorithms for GMM computation.

The common way to recognize speech is the following: we take waveform, split it on utterances by silences then try to recognize what's being said in each utterance. To do that we want to take all possible combinations of words and try to match them with the audio. We choose the best matching combination. There are few important things in this match.

First of all it's a concept of features. Since number of parameters is large, we are trying to optimize it. Numbers that are calculated from speech usually by dividing speech on frames. Then for each frame of length typically 10 milliseconds we extract 39 numbers that represent the speech. That's called feature vector. They way to generates numbers is a subject of active investigation, but in simple case it's a derivative from spectrum.

Second it's a concept of the model. Model describes some mathematical object that gathers common attributes of the spoken word. In practice, for audio model of senone is Gaussian mixture of its three states - to put it simple, it's a most probable feature vector. From concept of the model the following issues raised - how good does model fits practice, can model be made better of its internal model problems, and how adaptive model is to the changed conditions.

The model of speech is called Hidden Markov Model or HMM, it's a generic model that describes black-box communication channel. In this model process is described as a sequence of states which change each other with certain probability. This model is intended to describe any sequential process like speech. It has been proven to be really practical for speech decoding.

Third, it's a matching process itself. Since it would take a huge time more than universe existed to compare all feature vectors with all models, the search is often optimized by many tricks. At any

points we maintain best matching variants and extend them as time goes producing best matching variants for the next frame.

An acoustic model contains acoustic properties for each senone. There are context-independent models that contain properties (most probable feature vectors for each phone) and context-dependent ones (built from senones with context).

A phonetic dictionary contains a mapping from words to phones. This mapping is not very effective. For example, only two to three pronunciation variants are noted in it, but it's practical enough most of the time. The dictionary is not the only variant of mapper from words to phones. It could be done with some complex function learned with a machine learning algorithm.

A language model is used to restrict word search. It defines which word could follow previously recognized words (remember that matching is a sequential process) and helps to significantly restrict the matching process by stripping words that are not probable. Most common language models used are n-gram language models-these contain statistics of word sequences-and finite state language models-these define speech sequences by finite state automation, sometimes with weights. To reach a good accuracy rate, your language model must be very successful in search space restriction. This means it should be very good at predicting the next word. A language model usually restricts the vocabulary considered to the words it contains. That's an issue for name recognition. To deal with this, a language model can contain smaller chunks like sub words or even phones. Please note that search space restriction in this case is usually worse and corresponding recognition accuracies are lower than with a word-based language model.

3.1.1 Features of PocketSphinx

- All the processing takes place on the Raspberry Pi, so it is capable of being used offline.
- It supports real time speech recognition.
- Pocketsphinx is resource-efficient.
- Pocketsphinx supports many languages out-of box. It supports US English, Chinese, French, Russian, German, Dutch and more without need to train anything.
- Pocketsphinx is completely free software.
- Available bindings for several programming languages are present.

- **3.1.2 Installation**

The following are the steps for installation of Pocket Sphinx:

- Setup and properly configure ALSA [Advanced Linux Sound Architecture].
- Check your microphone is visible or not and if on which usb extension.
- Download sphinxbase latest and extract it.
- Download pocketsphinx and extract it.
- Run it.

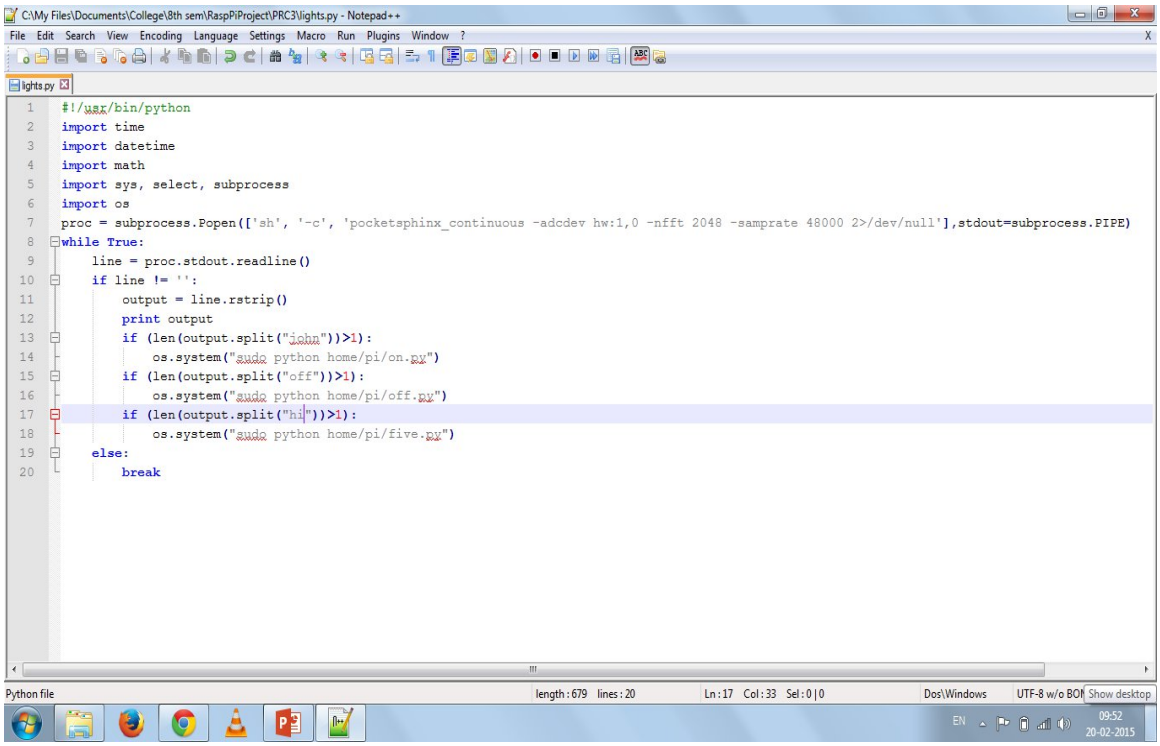

Fig 3.1 Lights conglomerate program

3.1.3 Modes of Operation

Using the voice recognition software, we have operated the LED in 3 modes. They are:

1] On Mode

2] Off Mode

3] Blink Mode

3.1.3.1 ON MODE

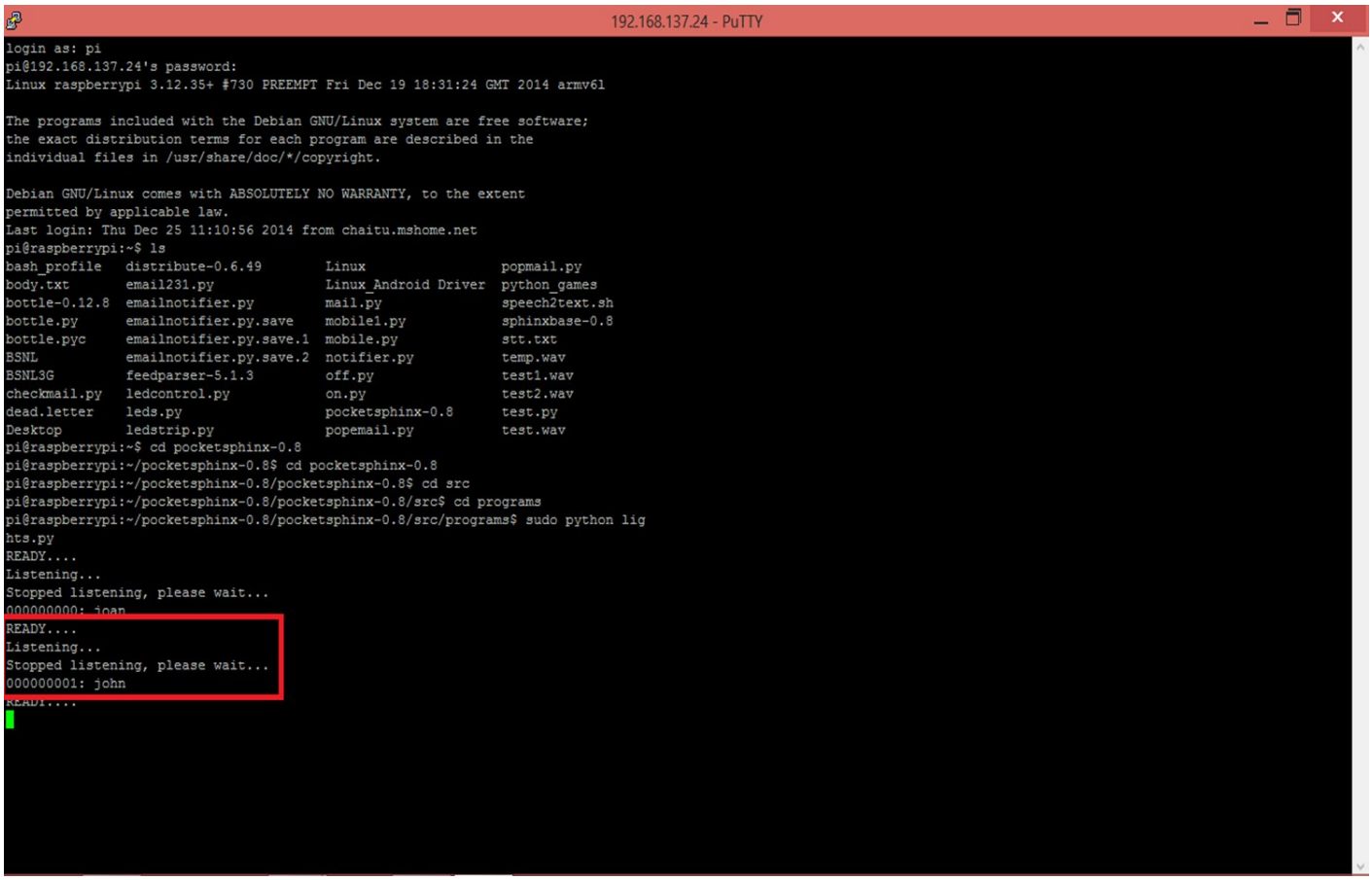

Fig 3.2 Execution of ON Mode

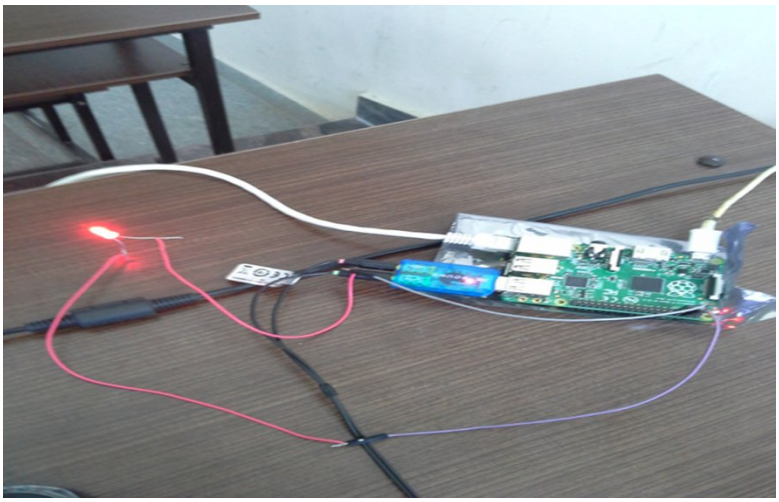

Fig 3.3 Result of ON Mode

3.1.3.2 OFF MODE

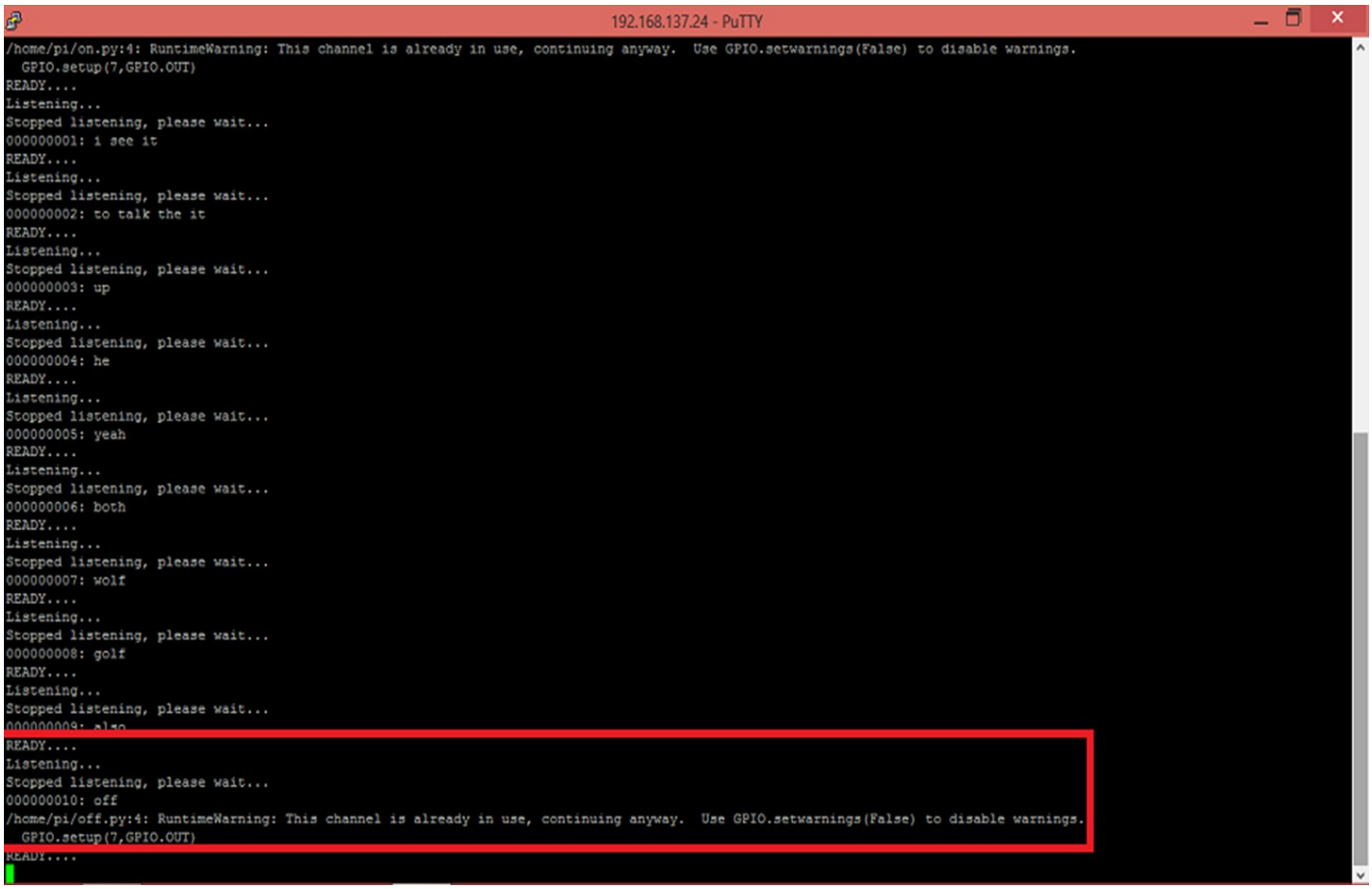

Fig 3.4 Execution of OFF Mode

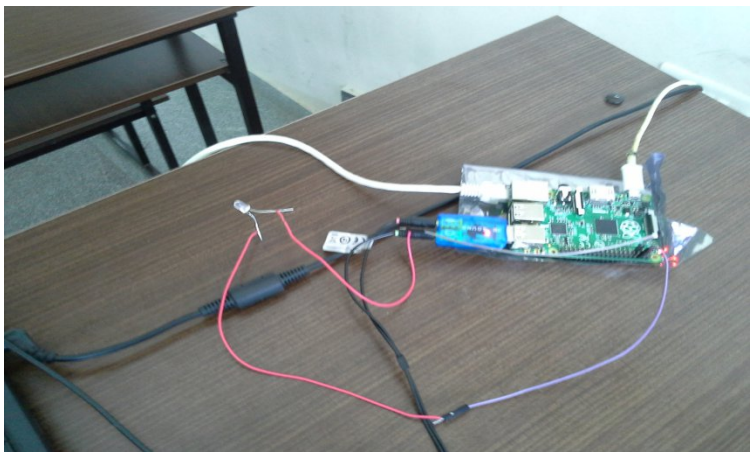

Fig 3.5 Result of OFF Mode

3.1.3.3 BLINK MODE

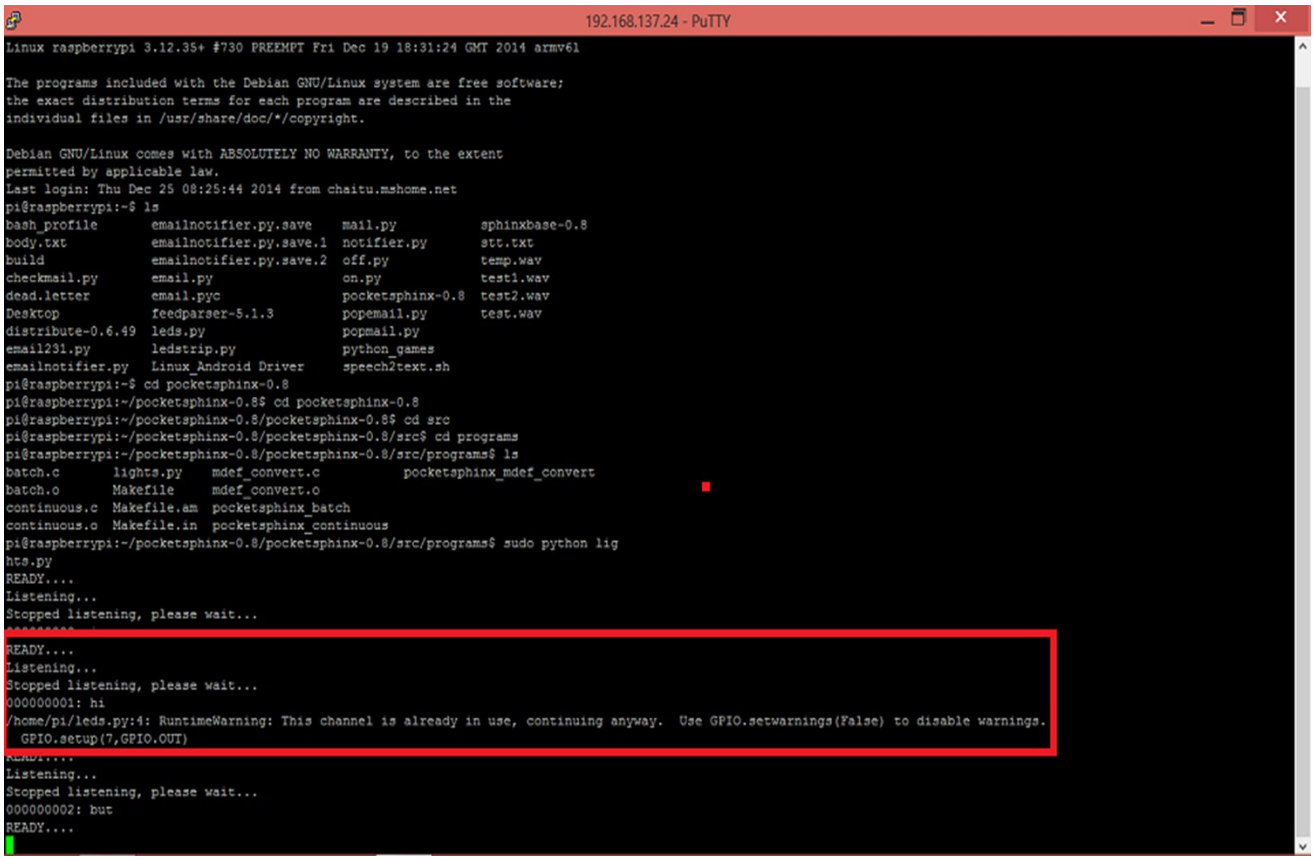

Fig 3.6 Execution of BLINK Mode