CHAPTER 1
INTRODUCTION

1.1 PURPOSE OF IMPLEMENTATION

With the traditional methods, the industrial parameters are monitored through individual LCD displays. The parameters are measured manually by the worker. For monitoring the parameters in various locations, the individual worker has to be present and has to keep a check on the parameters. The parameters has to be monitored continuously. In case, the measured parameter value exceeds certain value at the instant of that monitoring, the control process will be handled by the worker and the parameter value is regulated. Assigning individual worker for parameter is very difficult and manpower required is also very high. If any misinterpretation occurs, then that may lead a huge loss to the industry. In this era of technology, where innovations are made every day to replace or reduce human work. We propose a Smart Controlling system using sensors and relays. This monitors the internal parameters of the industry.

1.2 EMBEDDED SYSTEMS

An embedded system is combination of computer hardware and software, either fixed incapability or programmable, that is designed for a specific function or for specific functions within a larger system. Industrial machines, agricultural and process industry devices, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys as well as mobile devices are all possible locations for an embedded system. These are computing systems, but can range from having no user interface (UI) for example, on devices in which the embedded system is designed to perform a single task to complex graphical user interfaces (GUI), such as in mobile devices. User interfaces can include buttons, LEDs, touchscreen sensing and more. Some systems use remote user interfaces as well. Embedded systems can be microprocessor or microcontroller based. In either case, there is an integrated circuit (IC) at the heart of the product that is generally designed to carry out computation for real-time operations. Microprocessors are visually indistinguishable from microcontrollers, but whereas the microprocessor only implements a central processing unit (CPU) and thus requires the addition of other components such as memory chips, microcontrollers are designed as self-

contained systems. Microcontrollers include not only a CPU, but also memory and peripherals such as flash memory, RAM or serial communication ports. Because microcontrollers tend to implement full (if relatively low computer power) systems, they are frequently put to use on more complex tasks.

1.3 EMBEDDED SYSTEMS IN INDUSTRY

The embedded systems are used in various industrial applications such as process control, sensors, actuators, robotics etc. The adoption of embedded systems in industrial applications provide power efficiency with high performance and robust environmental design which resist water, moisture, dust and extreme temperature conditions. The other major advantage of industrial embedded systems is it supports cost effective and advanced Human Machine Interface (HMI), supports high speed wired and wireless communication and features for safety implementation. The conventional micro-controllers and micro-processors in industrial applications are now replaced by System on chip (SoC) and System on module (SoM) embedded platforms.

The rising focus of manufacturers to improve the energy efficiency has resulted in adoption of embedded system supported devices, which is the major driver for the growth of industrial embedded systems market. The increase in adoption of smart embedded system with complex functionalities such as imaging, smart sensors, wireless connectivity etc. to enhance the production efficiency is expected to drive the growth of global industrial embedded systems market. The technological advancements in embedded systems increased reliability, less operational cost, reduced power consumption, enhanced applications etc. is expected to propel the growth of global industrial embedded systems market. The rising adoption of Industrial Internet of Things (IIoT) solutions in developed economies is expected to boost the global industrial embedded systems growth. Japan accounts for significant share in industrial embedded systems market due to well-established embedded systems industry in the country.

Application domains have had a considerable impact on the evolution of embedded systems in terms of required methodologies and supporting tools and resulting technologies. A good example is the accelerated evolution of the SoC design to meet demands for computing power posed by DSP, and network and multimedia processors. SoC based designs are slowly making inroads in to the area of industrial automation to implement complex field-area intelligent devices which integrate intelligent sensor/actuator functionality by providing on-

chip signal conversion, data and signal processing, and communication functions. There is a growing tendency to network field-area intelligent devices around industrial communication networks, or fieldbuses. The global industrial embedded systems market can be divided into seven regions, Western Europe, Eastern Europe, Asia Pacific Excluding Japan and Middle East and Africa. Western Europe accounts for major share in global industrial embedded systems market. This is attributed to the well-established manufacturing industries in the region. The rising adoption of embedded system assisted automation system is expected to drive the growth of industrial embedded systems market in the region. North America holds significant share in global industrial embedded systems market. The digital transformation of industries and adoption of Industrial Internet of Things solutions is expected to drive the growth of industrial embedded systems market in the region. APEJ is expected to generate significant revenue in industrial embedded systems market during the forecast, owing the rising industrialization in the region.

1.4 INTERNET OF THINGS

Internet of Things is an ecosystem of connected physical objects that are accessible through the internet. The 'thing' in IoT could be a person with a heart monitor or an automobile with built-in-sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affects the decisions taken.

The IoT is a giant network of connected things and people all of which collect and share data about the way they are used and about the environment around them. That includes an extraordinary number of objects of all shapes and sizes – from smart microwaves, which automatically cook your food for the right length of time, to self-driving cars, whose complex sensors detect objects in their path, to wearable fitness devices that measure your heart rate and the number of steps you've taken that day, then use that information to suggest exercise plans tailored to you. There are even connected footballs that can track how far and fast they are thrown and record those statistics via an app for future training purposes. Devices and objects with built in sensors are connected to an Internet of Things platform, which integrates data from the different devices and applies analytics to share the most valuable information with applications built to address specific needs. These powerful IoT platforms can pinpoint exactly

what information is useful and what can safely be ignored. This information can be used to detect patterns, make recommendations, and detect possible problems before they occur. IoT is short for Internet of Things. The Internet of Things refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.

The Internet of Things extends internet connectivity beyond traditional devices like desktop and laptop computers, smartphones and tablets to a diverse range of devices and everyday things that utilize embedded technology to communicate and interact with the external environment, all via the Internet.

1.5 APPLICATIONS OF IOT

- **Smart home**

Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels. More than 60,000 people currently search for the term “Smart Home” each month. This is not a surprise. The IoT Analytics company database for Smart Home includes 256 companies and start-ups.

- **Wearables**

Wearables remains a hot topic too. As consumers await the release of Apple’s new smart watch in April 2015, there are plenty of other wearable innovations to be excited about: like the Sony Smart B Trainer, the Myo gesture control, or Looksee bracelet. Of all the IoT start-ups, wearables maker Jawbone is probably the one with the biggest funding to date.

- **Smart City**

Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Its popularity is fuelled by the fact that many Smart City solutions promise to alleviate real pains of people living in cities these days. IoT solutions in the area of Smart City solve traffic congestion problems, reduce noise and pollution and help make cities safer.

- **Smart grids**

Smart grids is a special one. A future smart grid promises to use information about the behaviours of electricity suppliers and consumers in an automated fashion to improve the efficiency, reliability, and economics of electricity. 41,000 monthly Google searches highlights the concept's popularity.

- **Industrial internet**

The industrial internet is also one of the special Internet of Things applications. While many market researches such as Gartner or Cisco see the industrial internet as the IoT concept with the highest overall potential, its popularity currently doesn't reach the masses like smart home or wearables do.

1.6 INDUSTRIAL AUTOMATION

Industry

In a general sense the term "Industry" is defined as follows. Definition: Systematic Economic Activity that could be related to Manufacture/Service/ Trade.

Automation

The word 'Automation' is derived from Greek words "Auto" (self) and "Matos" (moving). Automation therefore is the mechanism for systems that "move by itself". However, apart from this original sense of the word, automated systems also achieve significantly superior performance than what is possible with manual systems, in terms of power, precision and speed of operation. Automation is a set of technologies that results in operation of machines and systems without significant human intervention and achieves performance superior to manual operation

The Industrial Information Technology focuses on existing and emerging industrial applications of IT, and on evolving trends that are driven by the needs of companies and by industry-led consortia and organizations. Emphasizing fast growing areas that have major impacts on industrial automation and enterprise integration.

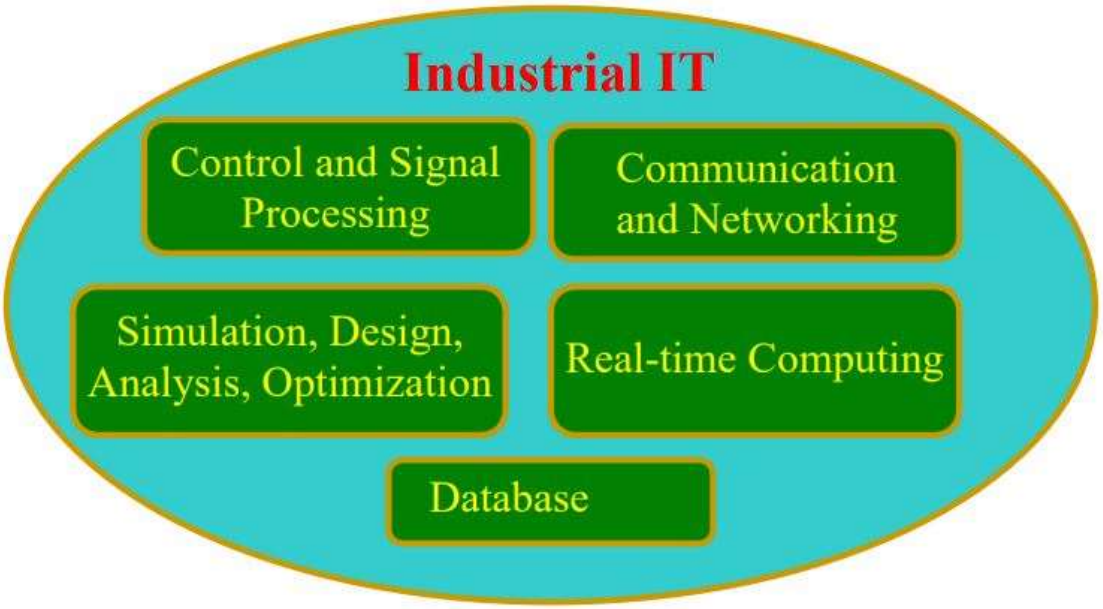


Figure 1.1 Major areas of IT which are used in the context of Industrial Automation

Role of automation in industry:

- Manufacturing processes, basically, produce finished product from raw/unfinished material using energy, manpower and equipment and infrastructure.
- Since an industry is essentially a "systematic economic activity", the fundamental objective of any industry is to make profit.
- Roughly speaking,

  Profit = (Price/unit – Cost/unit) x Production Volume (1) So profit can be maximised by producing good quality products, which may sell at higher price, in larger volumes with less production cost and time. Fig 2 shows the major parameters that affect the cost/unit of a mass-manufactured industrial product.
- Automation can achieve all these in the following ways,

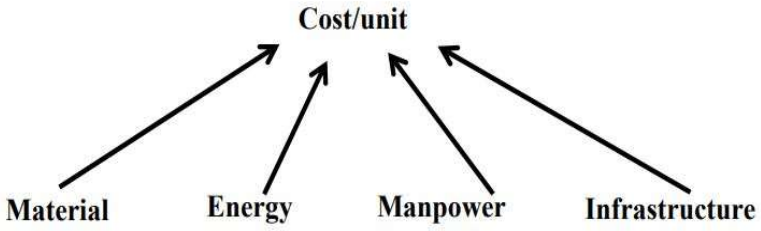


Figure 1.2 The Components of cost per unit Manufacturing Cost

1.7 POWER LINE COMMUNICATION(PLC)

Power line communications (PLC) uses the energy cables as the communication channel and the digital data are transferred via energy cables. PLC system is realized between transceivers modems located on the power lines front-end. Industrial control and home automation have rapidly been gaining popularity for the past decade. PLC, a new technology that sends data through existing electric cables alongside electrical current, is set to turn the largest existing network in the world, the electricity distribution grid, into a data transmission network. PLC will make it possible to both industrial control and home automation over power lines with economical and reliable solutions. Long-distance monitoring of alarms and air-conditioning systems, comfortable control of intelligent household appliances, and off-site reading of electricity meters will all become feasible-simply via the power grid. BPL injectors, repeaters, extractors and customer premises equipment (CPE) are the basic devices installed to enable power line network to provide high-speed Internet access.

Power Line Carrier communication systems consist of a high frequency signal injection over the electrical power lines. This kind of technology has been used since the 1950 decade in order to provide signaling and ripple control in High Voltage lines, at transmission level. In the last years the interest for this technology has suffered a revival because the impressing increase of the mobile telecommunications has brought a big development in transmission technologies for this kind of communications. In particular, new modulation technologies used for wireless communication are especially suitable for PLC communication and make massive data transmissions possible. Besides, the opening of the market, the need to integrate Distributed Energy Resources (DER) and the increase of the power supply demand create a new scenario in which the approach of the energy distribution system has to change. In such a scenario, the distribution system needs to be automated in order to give a satisfactory response to the problems that will eventually appear. Currently PLC communications can be broadband as well as narrowband and both cases present successful transmissions. Thus, it would be possible to think of an automated distribution scenario with PLC used as a communication link used for multiple applications. This gives a brief description of the power line carrier operations (this includes the 9 equipment's implored in facilitating broad band over power lines) and its viability in the Kenyan power grid. It also tackles the design issues encountered in broadband over power lines. In addition, it presents a cost comparison and economic benefits of broadband over power lines as compared with other broad band providers. Most private dwellings do not have dedicated

neither low nor high-speed network cabling installed, and the labour costs required to install such wiring is often quite high. Power line communication is an emerging home networking technology that allows consumers to use their already existing electrical wiring systems to connect home appliances to each other and to the Internet. Home networks power-line technology can control anything that plugs into an outlet, including lights, televisions, thermostats, alarms, home automation modules and so on. If there is the availability of multiple power outlets in every room, the home power line infrastructure represents an excellent network to share data among intelligent devices, also with high data transfer rate, up to a few hundreds of Mbps (Megabytes per second).

Power line communication is an emerging home network technology that allows consumers to use their already existing wiring system to connect home appliances to each other and to the Internet. Noise in power line communication and impulsive noise are presented in this paper. The PLC channel is discussed to such an extent. Power line communication which is also known as Power line carrier, power line digital subscriber line (PDSL), mains communication, power-line telecommunications, or power line networking (PLN) uses the existing electrical network for communication. So, the cost of installation is lower than other communication system and availability of communication service can be everywhere outlets exist.

PLC modems are used to make communication in power supply networks. Data signal from conventional communication devices, (computer, telephone) is converted by PLC modem in a form that is suitable for transmission over power lines. Although, power supply network is not designed for data communication. The PLC transmission channel has some negative properties as frequency-dependent attenuation, changing impedance, fading and unfavorable noise condition. However, to provide higher data rates PLC network has to operate in a frequency spectrum of up to 30 MHz PLC network produces electromagnetic radiation and disturb other services operating in the same frequency range.

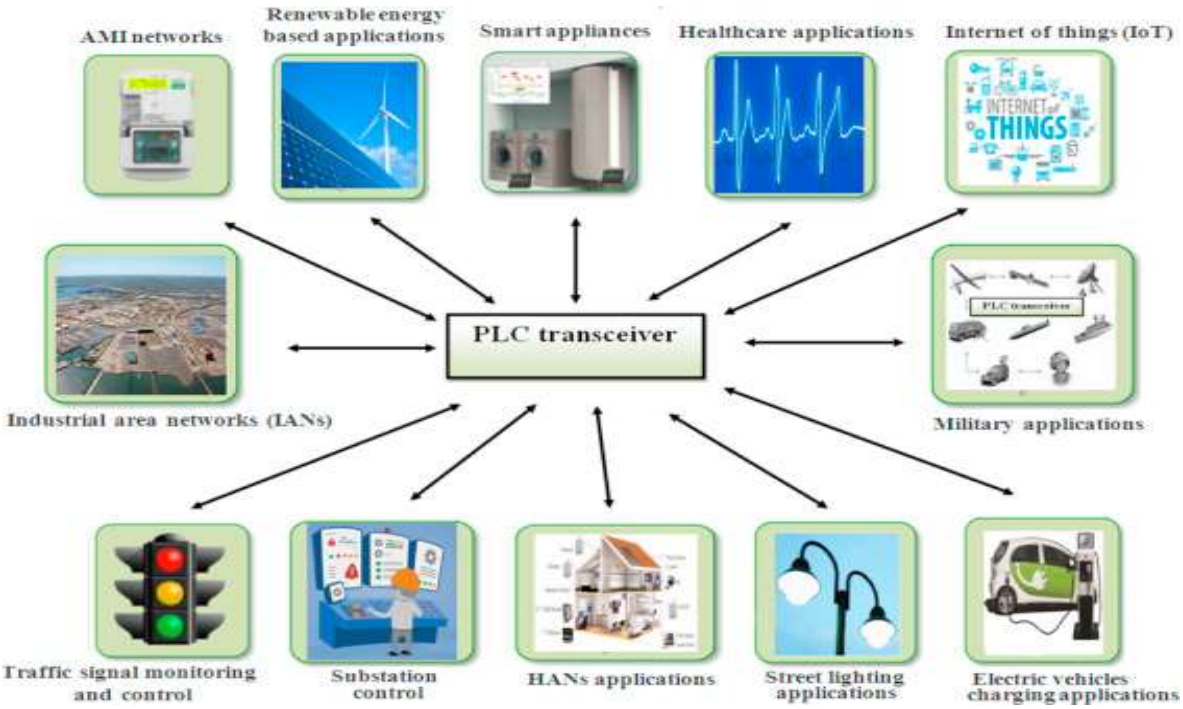


Figure 1.3 The Major Areas of Power Line Communication

PLC is divided into two groups: narrowband PLC allowing data rates up to 100 kbps and broadband PLC allowing data rates beyond 2 Mbps. With the inevitable arrival of broadband access, the demand for digital voice, video, internet data within the home increases continuously. PLC technology allows the uses of existing and widespread power distribution infrastructure to provide high speed networking capabilities along with many other benefits.

CHAPTER 2

DESIGN ASPECTS AND APPROACH

2.1 BLOCK DIAGRAM

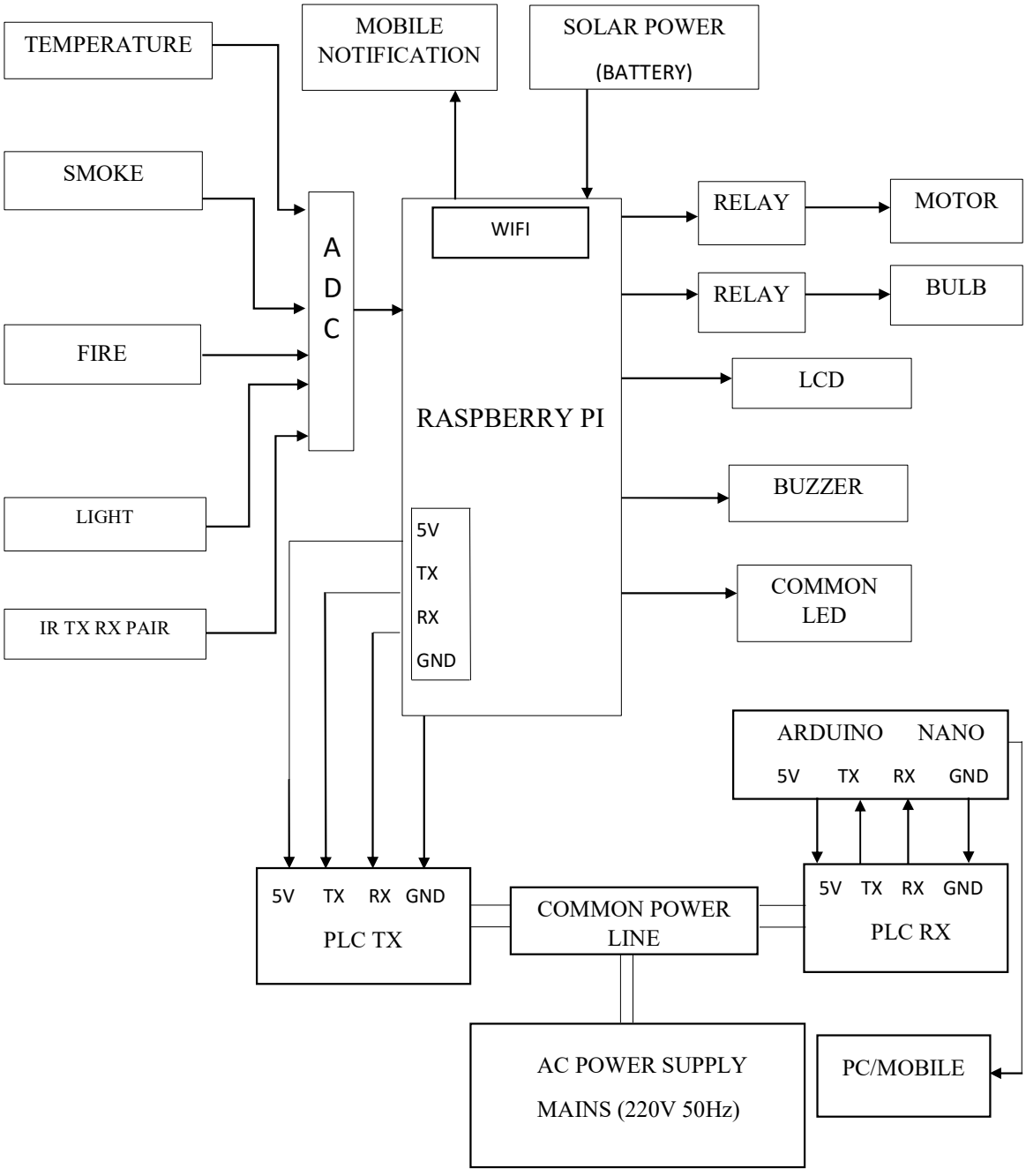


Figure 2 Block Diagram

2.2 BLOCK DIAGRAM DESCRIPTION

The block diagram consists of Temperature Sensor (LM35), Smoke Sensor (MQ2), Fire Sensor (Infrared Receiver Ignition Source Detection Module), Light Sensor (LDR 5mm Through-Hole), and IR Sensor (IR Tx & Rx). Temperature Sensor is connected to ADC (MCP 3008) Channel0. Smoke Sensor is connected to ADC Channel1. Fire Sensor is connected to ADC Channel2.Light Sensor is connected to ADC Channel3. IR Sensor is connected to ADC Channel4. ADC output pins are connected to Raspberry Pi's Pin 12 (MOSI), Pin 13(MISO), Pin 14(SCLK), Pin 10(CE0),3.3V and GND. Power Supply is given to Raspberry Pi using external power source via USB cable from Battery. The whole system is powered by Green Energy i.e. Solar Panel is used as a backup for the battery. The indicators used are Buzzer, Common Led. LCD is used for on-board diagnostics connected to Raspberry Pi's Pin 8(SDA), Pin 9(SCL),5V and GND. Relays are connected to Raspberry Pi followed by a Fan and Bulb. Blynk is used as an open source IOT platform through which data is send from the sensors to the cloud and it is displayed on the Blynk Dashboard and sends out Mobile Notification whenever a sensor value crosses beyond the threshold value.

In Power Line Communication the Raspberry Pi serial communication pins i.e. Pin15(TxD), Pin16(RxD), 5V and GND are connected to TX, RX, 5V and GND of KQ330 PLC Module TX respectively. The PLC TX module AC Line Output and PLC RX module AC Line Input are connected on a common power line having same phase (Extension Box) to the AC Mains (220V 50Hz). TX, RX, 5V and GND of KQ330 PLC Module RX are connected to TX, RX, 5V and GND of Arduino Nano. A USB cable is connected from the Arduino Nano to the PC/Mobile for Serial Monitor Display.

2.3 METHOD OF IMPLEMENTATION

In this project, we proposed a system where you can easily monitor and control the different parameters using sensors. In this we used a Raspberry Pi and Arduino Nano. Blynk is used as an open source IOT platform through which data is send from the sensors to the cloud. Here we used five sensors for the monitoring the Industrial System. In which all component plays crucial role & have individual responsibilities. Since we used five sensors out of which three sensors (Temperature, Smoke and Light) are analog sensors and rest of the two sensors

are digital (Fire and IR) where these sensors are interfaced to the ADC Input Channels. Temperature sensor which is used to monitor the temperature inside the industry, whenever it raises above the threshold value of 50, the module sends a mobile notification from Blynk, displays the current temperature reading value on the Dashboard and LCD, turns ON Buzzer and Common LED and also powers ON the Fan through relay. Smoke sensor which is used to monitor the smoke inside the industry, whenever it raises above the threshold value of 50, the module sends a mobile notification from Blynk, displays the current smoke reading value on the Dashboard and LCD, turns ON Buzzer and Common LED. Fire Sensor is used to detect flame inside the industry, whenever decreases below the threshold value of 25, the module sends a mobile notification from Blynk, displays the current temperature reading value on the Dashboard and LCD, turns ON Buzzer and Common LED. Light Sensor is used to monitor the light intensity inside the industry, whenever it decreases below the threshold value of 25,the module sends a mobile notification from Blynk , displays the current temperature reading value on the Dashboard and LCD, turns ON Buzzer and Common LED and also powers ON the Bulb through relay.IR Sensor is used for motion detection Sensor i.e. whenever a person enters into Restricted Areas, whenever decreases below the threshold value of 25,the module sends a mobile notification from Blynk , displays the current temperature reading value on the Dashboard ,turns ON Buzzer and Common LED.

In Power Line Communication the purpose of implementation is to transfer the data from one industry to another industry through the existing power lines where both are present near to each other. In this we have considered Light Sensor as a parameter to transfer the data from Sub Industry to the Main Industry i.e. whenever the Light senor value crosses a threshold value 50, a message signal is send from Raspberry Pi to PLC TX through Serial Communication. A local carrier signal is internally generated in both PLC TX and PLC RX having carrier frequency of 125KHz.Now message signal is modulated with the carrier signal (FSK Modulation) and the modulated signal that is obtained is now passed from PLC TX AC Line to the PLC RX AC Line. Here AC Line acts as a medium for the modulated signal to pass from TX to RX. Now the modulated signal that is received at the PLC RX is demodulated using the local carrier signal (FSK Demodulation) and the message signal is now obtained back, this message signal is passed to the Arduino Nano through Serial Communication. The message signal is now read on the serial monitor through a USB cable connected to Arduino Nano which also acts a power supply to PLC RX and Arduino Nano. Serial Monitor displays the message

to the Main industry officials, whenever the Light value decreases below a threshold value and they can take necessary actions immediately.

2.4 FLOW DIAGRAM

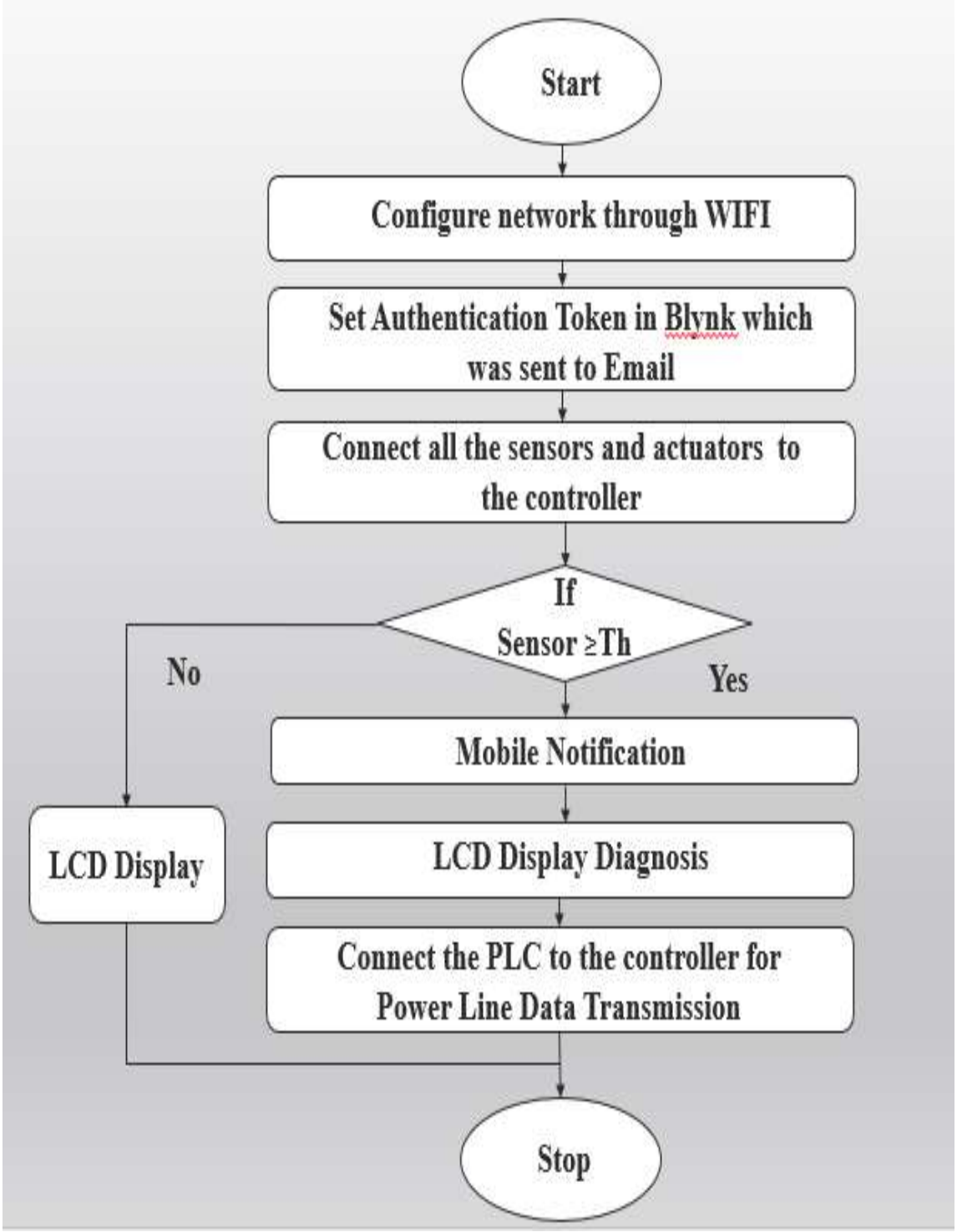


Figure 3 Flow Chart

SL NO	MATERIAL	COST
1	Raspberry Pi 3B	Rs. 2500
2	Arduino Nano	Rs 250
3	PLC TX and RX	Rs. 2500
4	Temperature Sensor	Rs. 60
5	Gas Sensor	Rs. 100
6	Fire Sensor	Rs. 100
7	Light Sensor	Rs. 20
8	IR	Rs. 100
9	ADC	Rs. 100
10	LCD	Rs. 120
11	I2C LCD Module	Rs. 80
12	Power Supply Converter	Rs 80
13	Push Button	Rs.2
14	Led	Rs.2
15	Battery	Rs. 20
16	Prefboard-1	Rs. 250
17	Prefboad-2	Rs. 150
18	Connecting Wires	Rs. 20
19	FRC Cable	Rs. 150
20	LED Bulb	Rs. 85
21	DC Motor	Rs. 100
22	Relay 2 Channel	Rs. 100
23	Wires	Rs. 20
24	Bulb Holder	Rs. 50
25	Potentiometer	Rs. 100
26	Raspberry Pi Cable	Rs. 50
27	Arduino Nano Cable	Rs. 50
28	Solar Panel	Rs. 550
TOTAL		**Rs. 7,709**

Table 7 Bill of Materials

CHAPTER 3
SOFTWARE AND HARDWARE COMPONENTS

3.1 SOFTWARE

3.1.1 RASPBIAN

Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Stretch and Raspbian Jessie. Since 2015 it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012. The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

Raspbian uses PIXEL, Pi Improved X-Window Environment, Lightweight as its main desktop environment as of the latest update. It is composed of a modified LXDE desktop environment and the Open box stacking window manager with a new theme and few other changes. The distribution is shipped with a copy of computer algebra program Mathematica and a version of Minecraft called Minecraft Pi. as well as a lightweight version of Chromium as of the latest version.

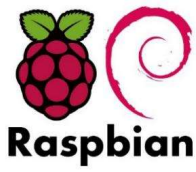


Figure 4.1 The image of Raspberry Pi and Raspbian

Raspbian is the main and basic software for RPi devices, officially supported by the Raspberry Pi Foundation. In fact, it is an operating system, based on Debian and optimized for Raspberry Pi hardware. It comes with lots of pre-installed pieces of software appropriate for most of ARM users and developers. And in this description contains almost all possible operating systems, as well as the Raspberry Pi images, compare and review major types of other software you can use for your complicated Raspberry Pi Projects. But the main operating system, ready-to-use and optimized to the needs of the most developers and makers is Raspbian. So, first thing firstly, let’s dig deeper this type of OS for RPi.

How to Install Raspbian

The Raspbian installation process is not complicated at all. Basically, as Raspberry Pi uses SD cards, all you need is to write an image on it. This is the safest and most robust way to bring the operating system to your hardware. Another way is when you already have some Raspbian on your Raspberry Pi and want to upgrade. In this case, you can perform terminal commands, beware that this may cause damage to your files. So, it's vital to backup your SD card right before! Well, let's look through both of this case

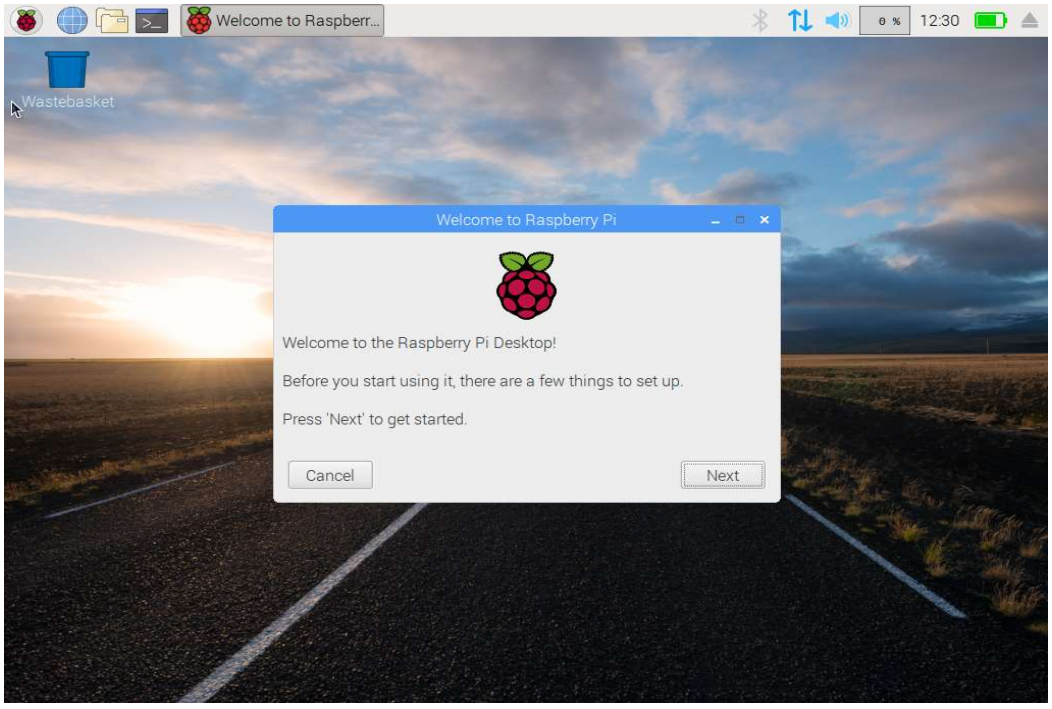


Figure 4.2 The Image of Raspberry Pi Raspbian OS Installation 1

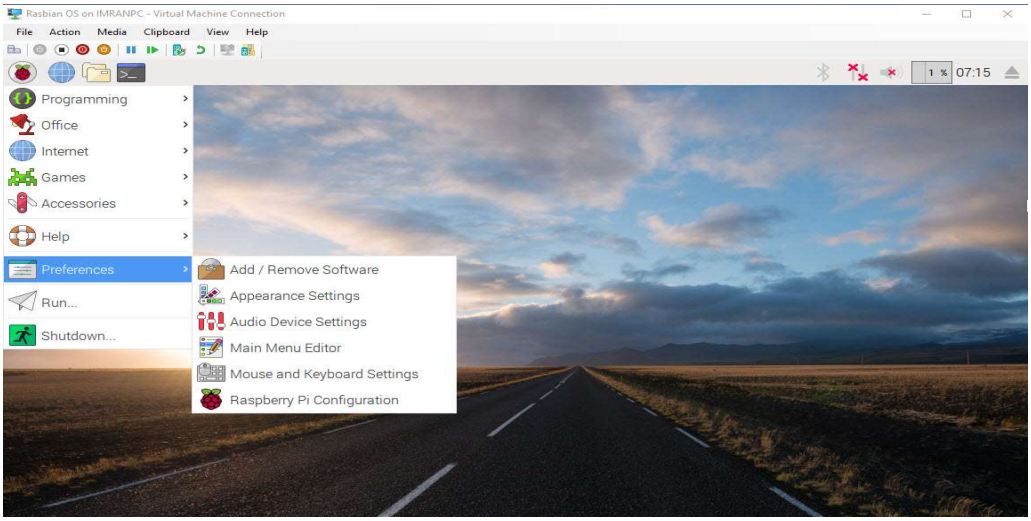


Figure 4.3 The image of Raspberry Pi Raspbian OS Installation 2

Writing A Raspbian Image on An SD Card

This way requires some additional desktop to write an image of Raspbian on your SD card. Depending on what operating system your desktop has (Mac, Windows or Linux) each one may have its own specific. So, I would recommend you to use Etcher, as it works on any of the mentioned and the process is always more or less the same. So, the guide includes the following steps:

1. Setup Etcher on your PC
2. Insert an SD card
3. Open the Etcher app and choose your downloaded Raspberry Pi .img or .zip file
4. Select the SD card
5. Push the “Flash!” button to start

All set! After that simply insert the SD card with an image into your device and switch it on. The system will boot automatically.

3.1.2 ARDUINO

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs.

Arduino is an open-source platform used for building electronics projects. The software,

too, is open-source, and it is growing through the contributions of users worldwide. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package. Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments.

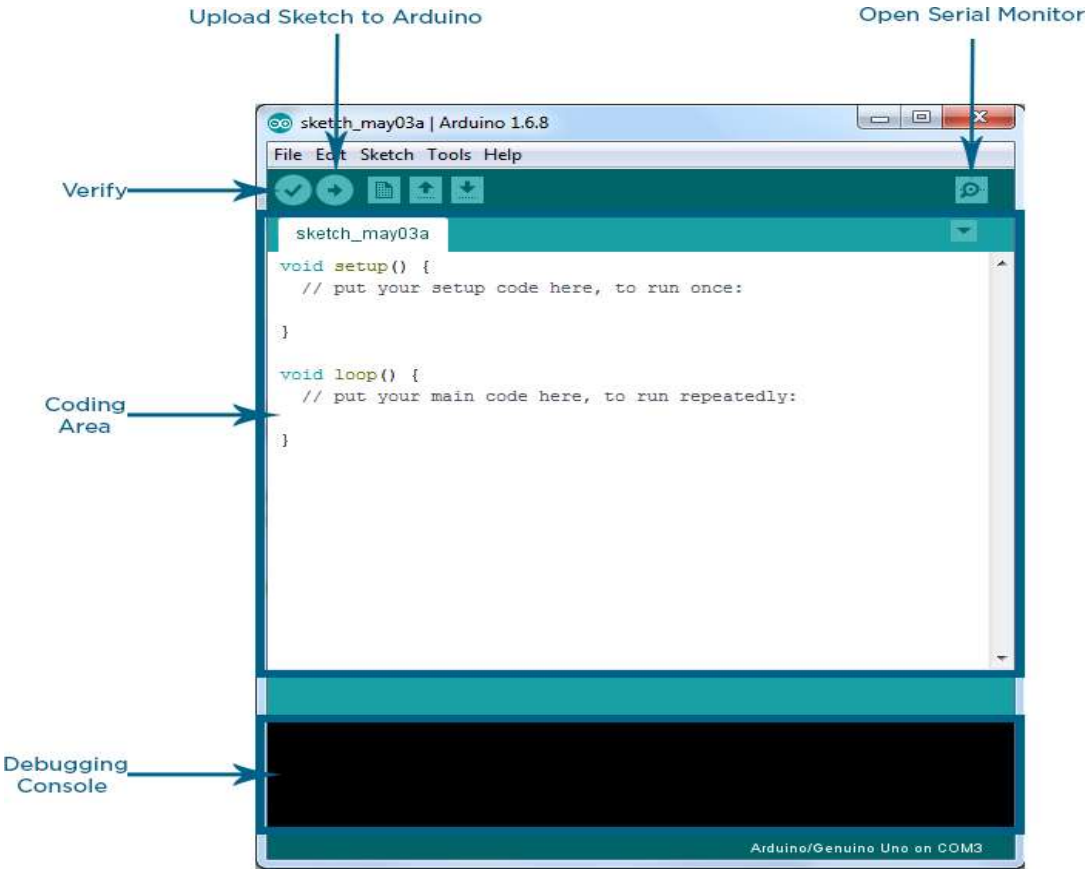


Figure 5 Arduino IDE

3.1.3 BLYNK

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the Internet of Your Things**.** Monitor local weather conditions, control LEDs from your phone, even send a tweet when it's time to water your plants! Blynk is an easy-to-use app builder that allows users to add buttons, sliders, graphs, and RGB controllers to their phone. The SparkFun Blynk Board is specially designed to work with the 'widgets' within the Blynk mobile app to create IoT projects. Every Blynk Board comes fully programmed and also includes a Blynk subscription code card (15k Energy at a $10 value). You'll be controlling the Blynk Board from half way around the world in no time. Blynk is called **"**the most user-friendly IoT platform**"** for a reason. Blynk supports **400+** hardware platforms and major connectivity types. From prototyping platforms like Arduino and Raspberry Pi to industrial grade ESP8266.

Intel, Sierra Wireless, Particle, Texas Instruments, and others. Secure, scalable, lightweight and fast. Ready to manage billions of requests from your edge devices. Deployable in minutes, Blynk Cloud is open-source. It can run in your environment, locally or on a dedicated Blynk Business Server.

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualized it and do many other cool things.

There are three major components in the platform:

- Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.

- Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

- Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Features of using BLYNK are

- Log and export data
- Change ui on the go
- HTTP REST API
- IFTTT integration
- SYNC STATES
- Similar API & UI for all supported hardware & devices
- Connection to the cloud using-Wi-Fi, Bluetooth, Ethernet, USB (Serial),GSM
- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- History data monitoring via History Graph widget
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.

INSTALLATION STEPS IN RASPBERRY PI

- Check if JavaScript is installed on your device
- Install Blynk library: https://github.com/vshymanskyy/blynk-library-js
- Check if Node.js is installed.

  Open the console (terminal) on your board and type:

  node --version

  or

  nodejs --version

You should see something like:

v0.10.38

For Raspberry Pi

Check that your board is connected to the internet, run in it's terminal:

curl -sL "https://deb.nodesource.com/setup_6.x" | sudo -E bash -

The previous command updates our package repository to include the required packages.

- Now install Node.js and Blynk!

sudo apt-get update && sudo apt-get upgrade

sudo apt-get install build-essential

sudo npm install -g npm

sudo npm install -g onoff

sudo npm install -g blynk-library

- Download and install Blynk mobile application either from Playstore or Appstore
- Create a new dashboard of type Generic, and send yourself an Auth Token.
- Add a Value Display widget and bind it to V9
- Add a Slider widget and bind it to V1
- Press Run (triangle in the upper right corne00r
- Now, run on your board (put your auth token):

  blynk-client 715f8cafe95f4a91bae319d0376caa8c

  Copy the above token into the script file

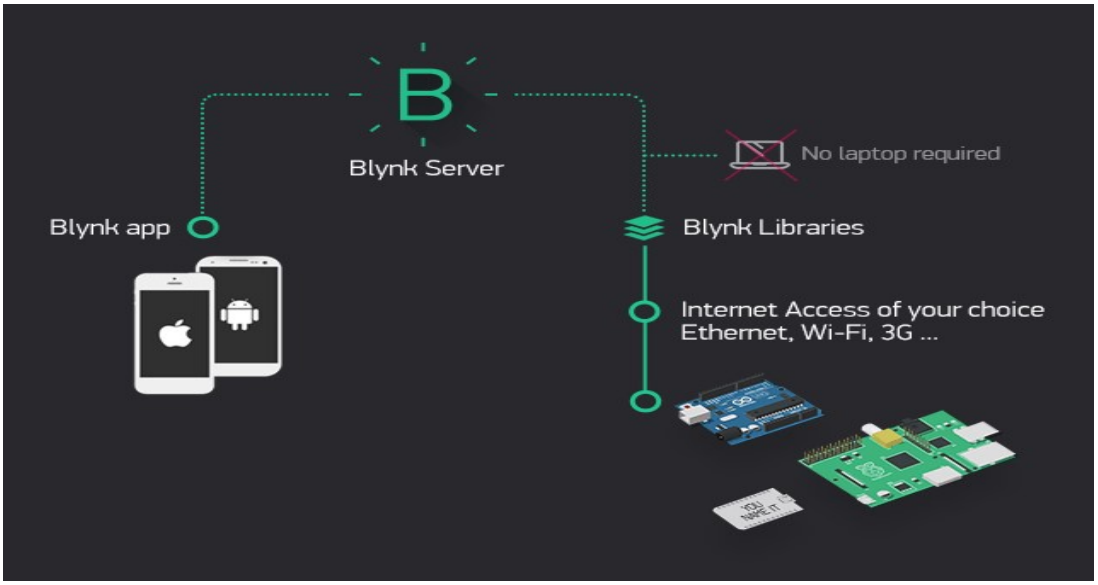


Figure 6.1 Blynk Working

3.1.4 PUTTY

SSH Using Windows

Depending on the version of Windows you are using and what software you have already installed, you may need to download an SSH client. The most commonly used client is called PuTTY and can be downloaded from greenend.org.uk.

Look for putty.exe under the heading For Windows on Intel:

1. Add your Raspberry Pi as a host

PuTTY does not include an installer package: it is a stand-alone .exe file. When you run it, you will see the configuration screen below:

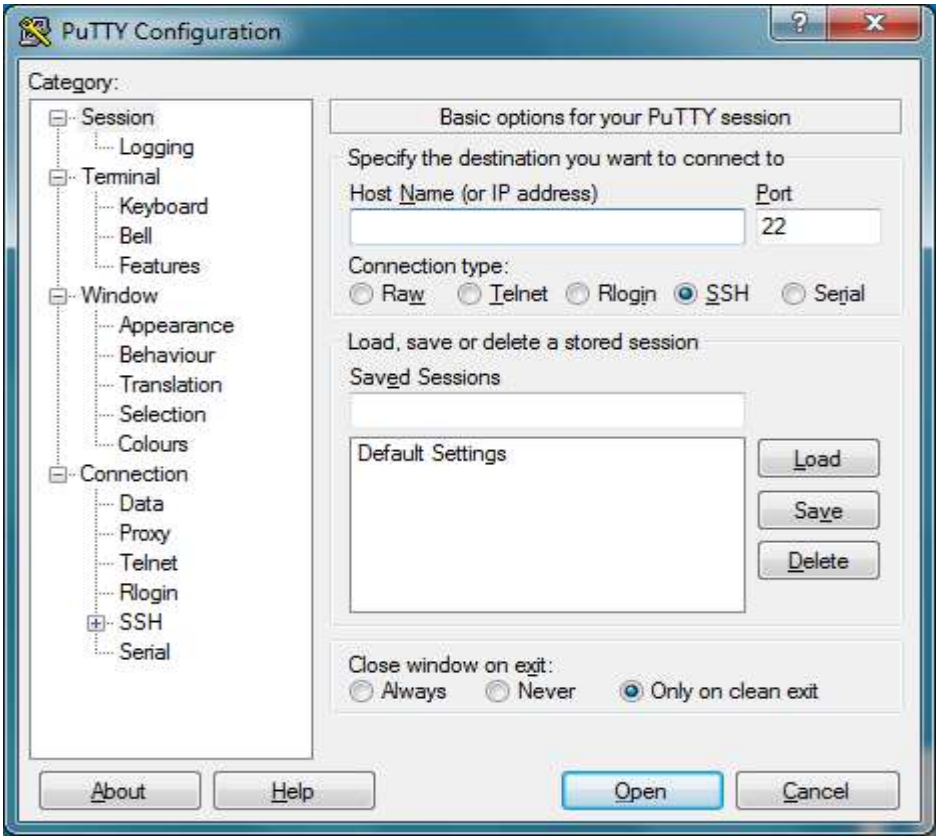


Figure 7.1 Putty Configuration

Type the IP address of the Pi into the Host Name field and click the Open button. If nothing happens when you click the Open button, and you eventually see a message saying Network error: Connection timed out, it is likely that you have entered the wrong IP address for the Pi.

If you do not know the IP address, type hostname -I in the Raspberry Pi command line. There are more ways to find your IP address here.

2.Connect

When the connection works you will see the security warning shown below. You can safely ignore it and click the 'Yes' button. You will only see this warning the first time PuTTY connects to a Raspberry Pi that it has not seen before.

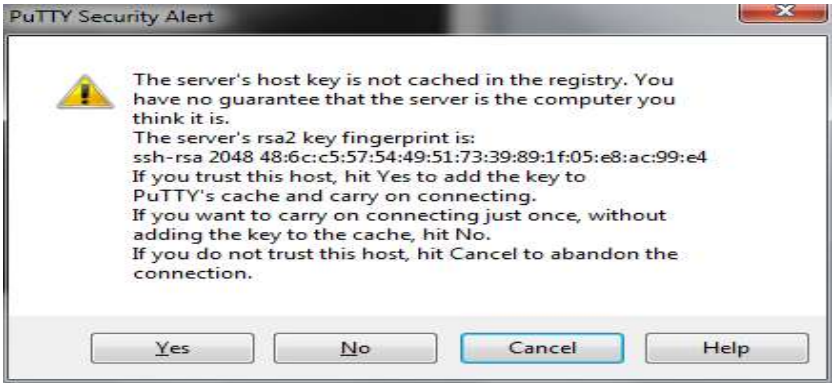


Figure 7.2 Putty Security Alert

You will now see the usual login prompt. Log in with the same username and password you would use on the Pi itself. The default login for Raspbian is pi with the password raspberry.

You should now have the Raspberry Pi prompt which will be identical to the one found on the Raspberry Pi itself.

```
pi@raspberrypi ~ $
```

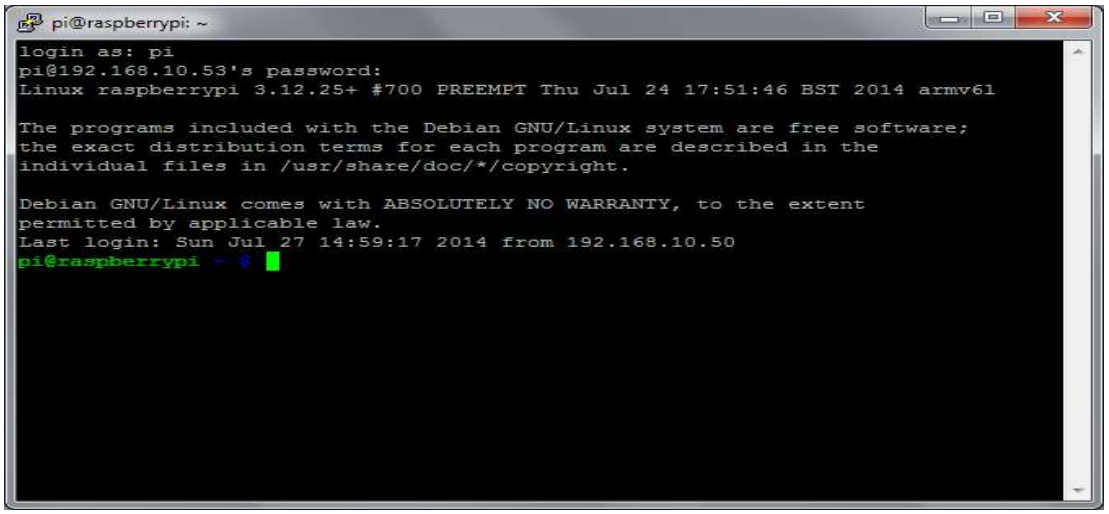


Figure 7.3 Putty Terminal

You can type exit to close the PuTTY window.

3. Modification, troubleshooting, and more…

Next time you use PuTTY, look for the Saved Sessions section in the bottom half of the configuration screen. If you use this, we recommend switching to the Connection page in the left-hand tree, and setting the Seconds between keepalives value to 30. Then switch back to the Session page in the tree before you click Save. Using this setting allows you to leave a PuTTY window open for long periods of time with no activity, without the Pi timing out and disconnecting you. A connection might be unsuccessful for various reasons. It is most likely that your device or Raspberry Pi are not connected properly; SSH is disabled; there is a typo in your code; or the IP address or credentials have changed. In the latter cases, you will need to update the host. For instructions on how to update a host, and for further PuTTY documentation, please see the PuTTY docs.

SSH using Mobile

This is free Android SSH app which is based on OpenSSH and Putty as its backend library. Inspired by opensource community and in the hope of extending usage of OpenSSH on Android devices, the Mobile SSH was created

.

Figure 7.4 Mobile SSH Configuration

Figure 7.5 Mobile SSH Terminal

3.1.5 SD CARD FORMATTER

Formatting an SDXC card for use with NOOBS. According to the SD specifications, any SD card larger than 32GB is an SDXC card and has to be formatted with the ex-FAT filesystem. This means the official SD Formatter tool will always format cards that are 64GB or larger as ex-FAT. The Raspberry Pi's bootloader, built into the GPU and non-updateable, only has support for reading from FAT filesystems (both FAT16 and FAT32), and is unable to boot from an ex-FAT filesystem. So, if you want to use NOOBS on a card that is 64GB or larger, you need to reformat it as FAT32 first before copying the NOOBS files to it.

The standard formatting tools built into Windows are limited, as they only allow partitions up to 32GB to be formatted as FAT32, so to format a 64GB partition as FAT32 you need to use a third-party formatting tool. A simple tool to do this is FAT32 Format which downloads as a single file named guiformat.exe - no installation is necessary. Run the SD Formatter tool first to ensure that any other partitions on the SD card are deleted. Then run the FAT32 Format (guiformat.exe) tool, ensure you choose the correct drive letter, leave the other options at their default settings, and click "Start". After it has finished, you can proceed with the rest of the NOOBS instructions. If the FAT32 Format tool doesn't work for you, alternative options are MiniTool Partition Wizard Free Edition and EaseUS Partition Master Free which are "home user" versions of fully featured partition editor tools, and so not as straightforward to use.

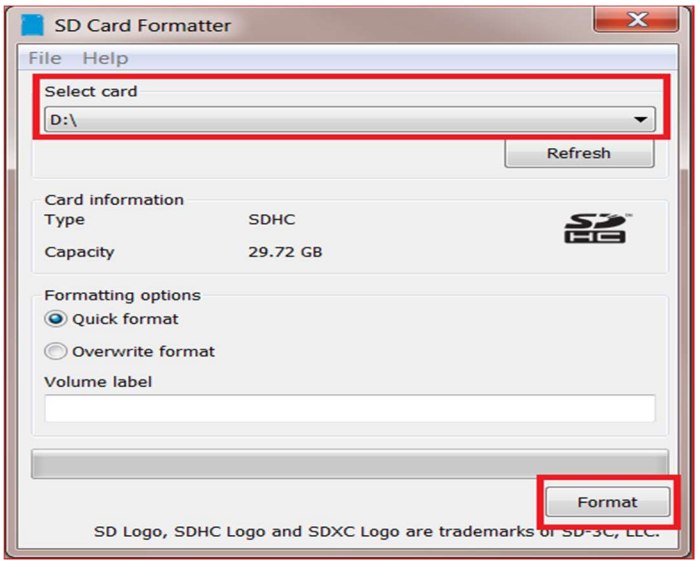


Figure 8 SD Card Formatter Configuration

The SD Memory Card Formatter formats SD Memory Card, SDHC Memory Card and SDXC Memory Card (respectively SD/SDHC/SDXC Cards) complying with the SD File System Specification created by the SD Association (SDA).

It is strongly recommended to use the SD Memory Card Formatter to format SD/SDHC/SDXC Cards rather than using formatting tools provided with individual operating systems. In general, formatting tools provided with operating systems can format various storage media including SD/SDHC/SDXC Cards, but it may not be optimized for SD/SDHC/SDXC Cards and it may result in lower performance.

SD/SDHC/SDXC Cards have a “Protected Area” for SD Card security purposes. The SD Memory Card Formatter does not format the protected area in the SD/SDHC/SDXC Cards. The protected area shall be formatted by an appropriate PC application or SD host devices that provide SD security function. The SD Memory Card Formatter doesn't support SD/SDHC/SDXC Card encrypted by the “BitLocker To Go" functionality of Windows. Please format the SD/SDHC/SDXC Card after it has been unlocked.

3.1.6 ADVANCED IP SCANNER

Advance IP Scanner is a Reliable and free network scanner to analyze LAN. The program shows all network devices, gives you access to shared folders, provides remote control of computers (via RDP and R admin), and can even remotely switch computers off. It is easy to use and runs as a portable edition. It should be the first choice for every network admin.

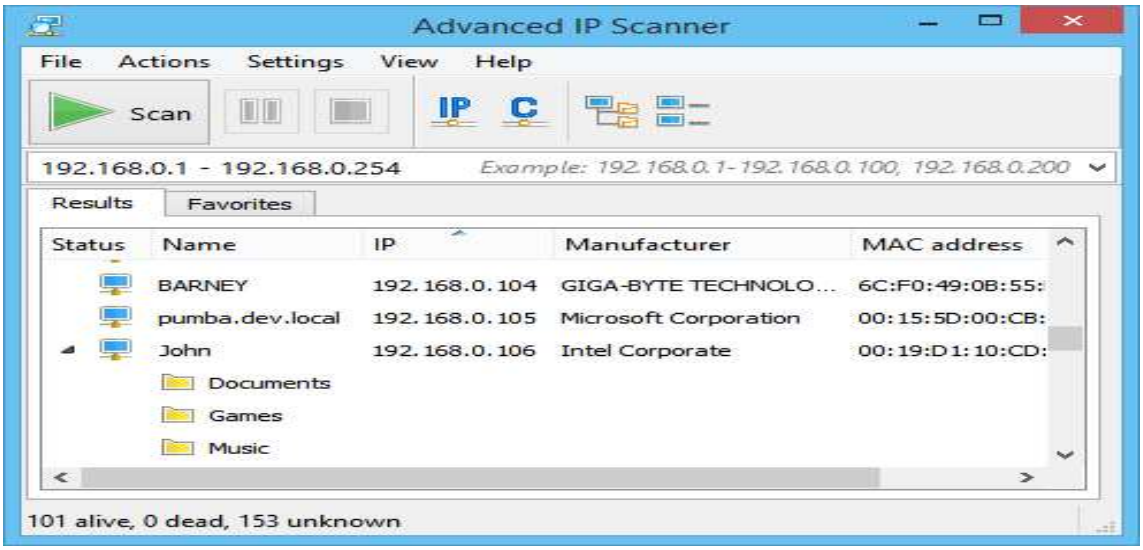


Figure 9 Advance IP Scanner

There may be times when you need to detect local IP addresses within your LAN (Local Area Network). This advanced IP scanner is absolutely free and yet it has already been adopted by more than 40 million users. Some basic functions include the ability to see all network devices to remotely control other computers and if required even to shut down computers within a network. So, it is clear to see why IT professionals enjoy this software.

3.1.7 XMING

Xming is an X11 display server for Microsoft Windows operating systems, including Windows XP and later. Xming provides the X Window System display server, a set of traditional sample X applications and tools, and a set of fonts. It features support of several languages and has Mesa 3D, OpenGL, and GLX 3D graphics extensions capabilities. The Xming X server is based on Cygwin/X, the X.Org Server. It is cross-compiled on Linux with the MinGW compiler suite and the Pthreads-Win32 multi-threading library. Xming runs natively on Windows and does not need any third-party emulation software. Xming may be used with implementations of Secure Shell (SSH) to securely forward X11 sessions from other computers. It supports PuTTY and ssh.exe, and comes with a version of PuTTY's plink.exe. The Xming project also offers a portable version of PuTTY. When SSH forwarding is not used, the local file Xn.hosts must be updated with host name or IP address of the remote machine where GUI application is started. The software has been recommended by authors of books on free software when a free X server is needed, and described as simple and easier to install though less configurable than other popular free choices like Cygwin/X.

Figure 10.1 Xming Configuration

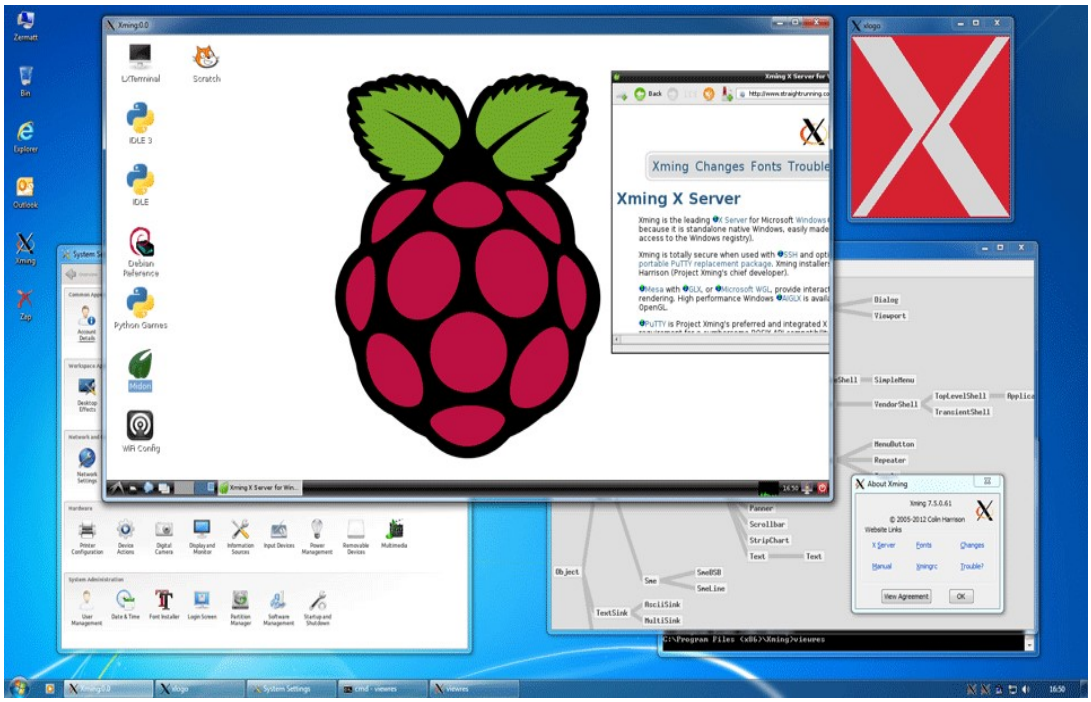


Figure 10.2 Xming Window

3.1.8 ETCHER BALENA

BalenaEtcher is a free and open-source utility used for burning image files such as .iso and .img files, as well as zipped folders to create live SD cards and USB flash drives. It is developed by balena, and licensed under Apache License 2.0. Etcher was developed using the Electron framework and supports Windows, macOS and Linux. The

latest release of balenaEtcher is version 1.4.9. balenaEtcher was originally called Etcher, but its name was changed on October 29, 2018 when Resin.io changed its name to Balena. Etcher is primarily used through a graphical user interface. Additionally, there is a command line interface available which is under active development. Future planned features include support for persistent storage allowing the live SD card or USB flash drive to be used as a hard drive, as well as support for flashing multiple boot partitions to a single SD card or USB flash drive.

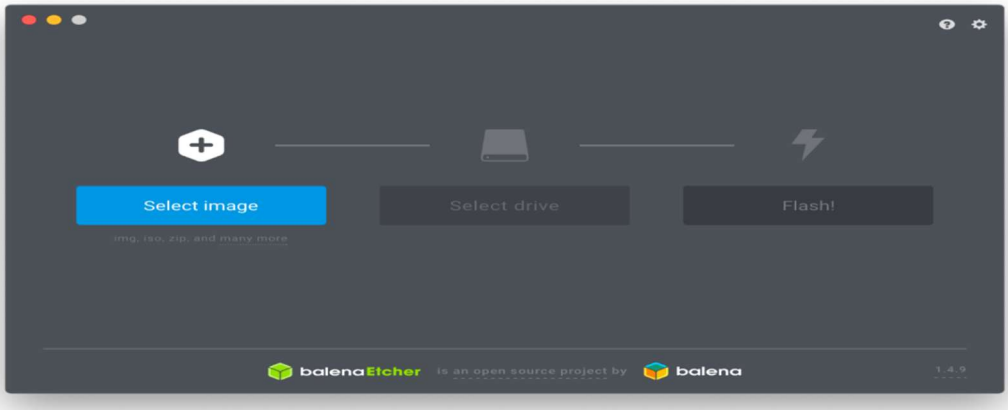


Figure 11 Etcher Balena

3.1.9 VNC VIEWER

VNC is a graphical desktop sharing system that allows you to remotely control the desktop interface of one computer (running VNC Server) from another computer or mobile device (running VNC Viewer). VNC Viewer transmits the keyboard and either mouse or touch events to VNC Server and receives updates to the screen in return. Sometimes it is not convenient to work directly on the Raspberry Pi. Maybe you would like to work on it from another device by remote control. VNC Viewer from RealVNC provides you with instant remote access to your chosen computer; a Mac, a Windows PC or a Linux machine, from anywhere in the world. VNC Viewer lets you view your computer's desktop, and also control its mouse and keyboard as though you were sitting directly in front of that computer. VNC Viewer is simple to install and use; just run the installer on the device you want to control from and follow the instructions. Optionally, there are MSIs available for remote deployment under Windows. If you don't have permission to install VNC Viewer on desktop platforms, you need to choose the

standalone option. You can see the desktop of the Raspberry Pi inside a window on your computer or mobile device. You'll be able to control it as though you were working on the Raspberry Pi itself.

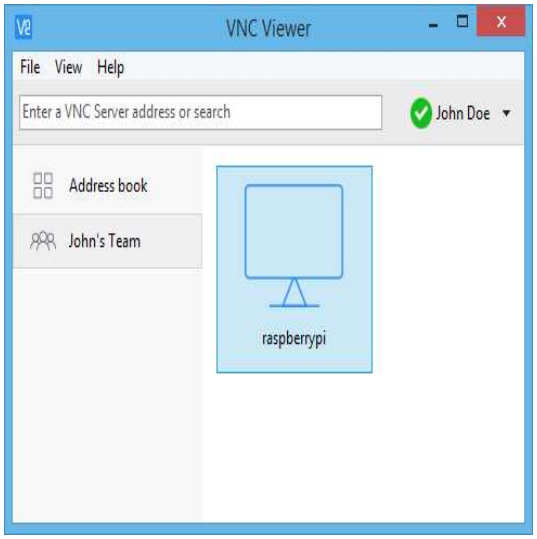


Figure 12.1 VNC Viewer

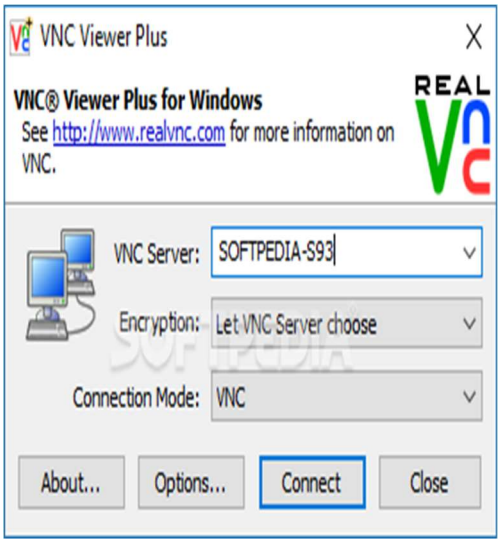


Figure 12.1 VNC Viewer Configuration

VNC is platform-independent – there are clients and servers for many GUI-based operating systems and for Java. Multiple clients may connect to a VNC server at the same time. Popular uses for this technology include remote technical support and accessing files on one's work computer from one's home computer, or vice versa.

3.1.10 LEAFPAD

Leafpad is an open source text editor for Linux, BSD, and Maemo. Created with the focus of being a lightweight text editor with minimal dependencies, it is designed to be simple and easy-to-compile. Leafpad is the default text editor for LXDE Desktop environment, including Lubuntu up to version 18.04 LTS. Released under the terms of the GNU General Public License, Leafpad is free software. On Linux, you have a choice of text editors. Some are easy-to-use but have limited functionality; others require training to use and take a long time to master but offer incredible functionality. Leafpad is a simple GTK+ text editor that emphasizes simplicity. As development focuses on keeping weight down to a minimum, only the most essential features are implemented in the editor. Leafpad is simple to use, is easily compiled, requires few libraries, and starts up quickly.

On Raspbian, you'll find an editor called Leafpad. This is a simple editor which opens in a window like a normal application. It allows use of the mouse and keyboard and has tabs and syntax highlighting.

You can use keyboard shortcuts, such as Ctrl + S to save a file and Ctrl + X to exit.

Figure 13.1 Leafpad Window

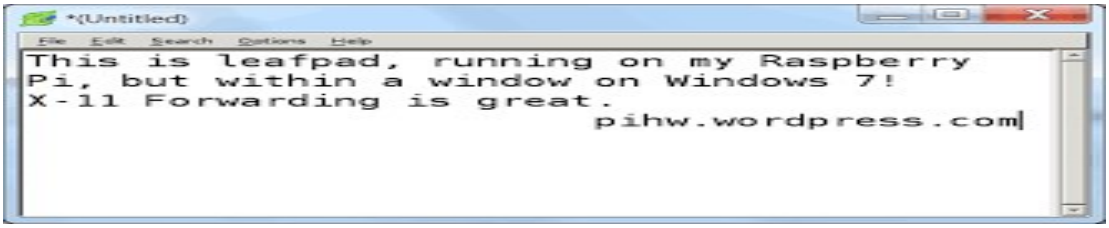


Figure 13.2 Leafpad Test Window

3.2 HARDWARE

3.2.1 RASPBERRY Pi

The Raspberry Pi is an open-source, Linux based, credit card sized computer board, Created by the Raspberry Pi Foundation. The Pi is an exciting and accessible means of improving computing and programming skills for people of all ages. By connecting to your TV or monitor and a keyboard, and with the right programming, the Pi can do many things that a desktop computer can do such as surf the internet and play video. The Pi is also great for those innovative projects that you want to try out - newer models are ideal for Internet of Things projects due to their processing power. With Pi 3, Wireless LAN and Bluetooth Low Energy are on-board too.

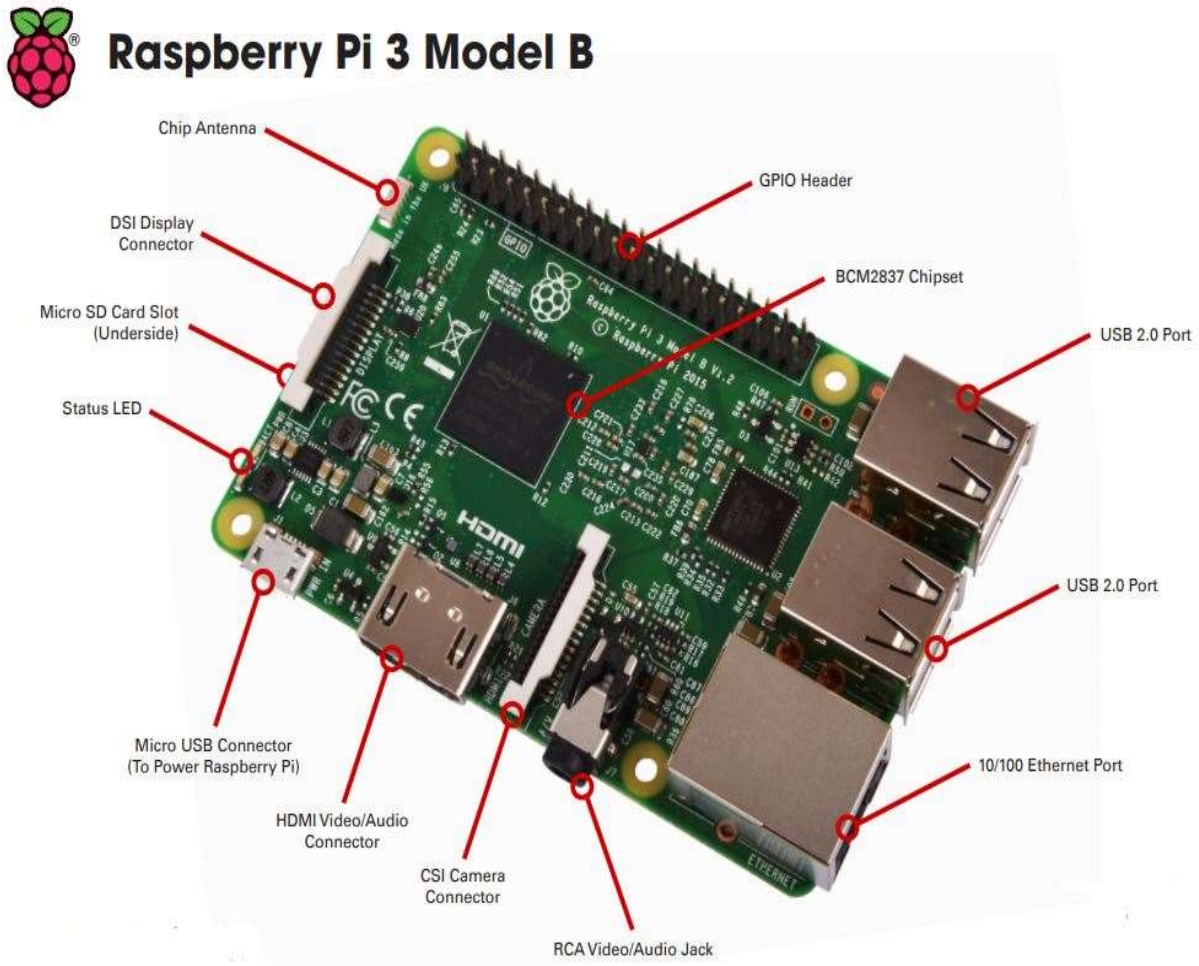


Figure 14.1 The Figure of Raspberry Pi

Specifications

Processor: Broadcom BCM2387 chipset.

1.2GHz Quad-Core ARM Cortex-A53

802.11 b/g/n Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)

GPU: Dual Core VideoCore IV® Multimedia Co-Processor. Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode.

Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure

Memory: 1GB LPDDR2

Dimensions: 85 x 56 x 17mm

Power: Micro USB socket 5V1, 2.5A

Operating System: Boots from Micro SD card, running a version of the Linux operating system or Windows 10 IoT

Ethernet: 10/100 BaseT Ethernet socket

Video Output: HDMI (rev 1.3 & 1.4 Composite RCA (PAL and NTSC)

Audio Output: Audio Output 3.5mm jack, HDMI

USB 4 x USB 2.0 Connector

GPIO Connector: 40-pin 2.54 mm (100 mil) expansion header: 2x20 strip

Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply lines

Camera Connector: 15-pin MIPI Camera Serial Interface (CSI-2)

Memory Card Slot: Push/pull Micro SDIO

Display Connector: Display Serial Interface (DSI) 15way flat flex cable connector with two data lanes and a clock lane

PIN GROUP	PIN NAME	DESCRIPTION
POWER SOURCE	+5V, +3.3V, GND and Vin	+5V -power output +3.3V -power output GND – GROUND pin
COMMUNICATION INTERFACE	UART Interface(RXD, TXD) [(GPIO15,GPIO14)]	UART (Universal Asynchronous Receiver Transmitter) used for interfacing sensors and other devices.
	SPI Interface(MOSI, MISO, CLK,CE) x 2	SPI (Serial Peripheral Interface) used for communicating with other boards or peripherals.
INPUT OUTPUT PINS	26 I/O	Although these some pins have multiple functions they can be considered as I/O pins.
PWM	Hardware PWM available on GPIO12, GPIO13, GPIO18, GPIO19	These 4 channels can provide PWM outputs.
EXTERNAL INTERRUPTS	All I/O	In the board all I/O pins can be used as Interrupts.

Table 1 Raspberry Pi-3 Pin Configuration

Name	Description
Ethernet	Base T Ethernet Socket
USB	2.0 (Four sockets)
Audio Output	3.5mm Jack and HDMI
Video output	HDMI
Camera Connector	15-pin MIPI Camera Serial Interface (CSI-2)
Display Connector	Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane.
Memory Card Slot	Push/Pull Micro SDIO

Table 2 Raspberry Pi 3 Board Connector

Key Benefits

- Low cost
- Consistent board format
- 10x faster processing
- Added connectivity

Key Applications

- Low cost PC/tablet/laptop
- Media centre
- Industrial/Home automation
- IoT applications
- Robotics
- Server/cloud server

What are the differences between the models?

Current versions of the Raspberry Pi are the Pi A+, Pi B+, Pi 2 B, Pi 3 B and Compute Module.

	Pi A+	Pi B+	Pi 2 B	Pi 3 B	Compute Module
Dimensions	66 x 56 x 14mm	85 x 56 x 17mm	85 x 56 x 17mm	85 x 56 x 17mm	67.5 x 30mm
SoC	BCM2835	BCM2835	BCM2836	BCM2837	BCM2835
Processor Core	ARM11	ARM11	ARM Cortex-A7	ARM Cortex-A53	ARM11
Processing Power	700 MHz	700 MHz	900 MHz	1.2 GHz	700 MHz
Memory	256 MB	512 MB	1 GB	1GB LPDDR2	512 MB
Ports	1x USB 2.0	4x USB 2.0 1x 10/100 Ethernet	4x USB 2.0 1x 10/100 Ethernet	4x USB 2.0 1x 10/100 Ethernet	N/A
GPIO	40	40	40	40	N/A

Figure 14.2 Comparision Between Different Models

There are three main **benefits** to the **Raspberry Pi 3** over the **Pi** 2.

1. It has Bluetooth.

2. It has Wi-Fi and

3. It has a more powerful CPU/GPU pair.

The Raspberry pi is a single computer board with credit card size, that can be used for many tasks that your computer does, like games, word processing, spreadsheets and also to play HD video. It was established by the Raspberry pi foundation from the UK. It has been ready for public consumption since 2012 with the idea of making a low-cost educational microcomputer for students and children. The main purpose of designing the raspberry pi board is, to encourage learning, experimentation and innovation for school level students. The raspberry pi board is a portable and low cost. Maximum of the raspberry pi computers is used in mobile phones. In the 2st century, the growth of mobile computing technologies is very high, a huge segment of this being driven by the mobile industries. The 98% of the mobile phones were using ARM technology

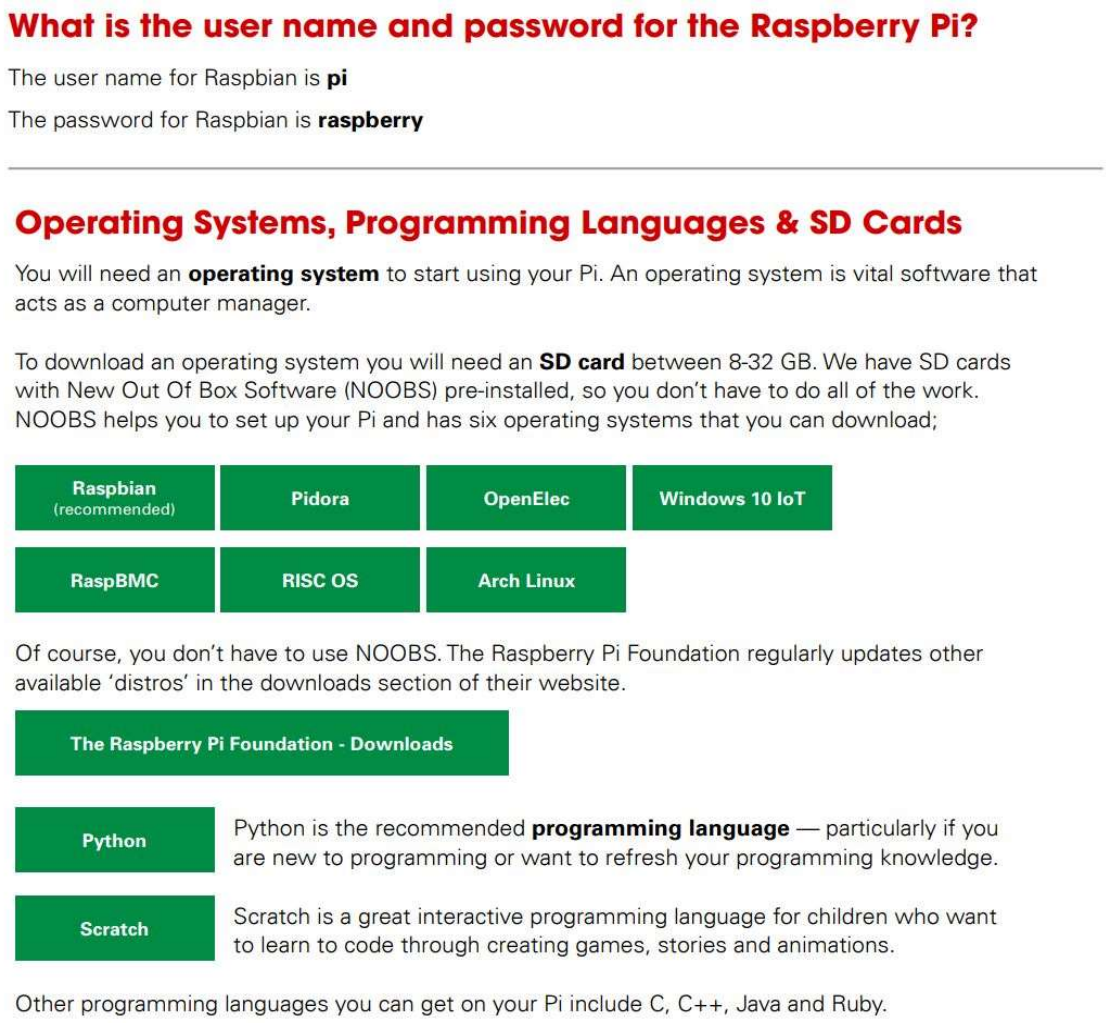


Figure 14.3 Raspberry Pi Authentication

User management in Raspbian is done on the command line. The default user is pi, and the password is raspberry. You can add users and change each user's password.

Once you're logged in as the pi user, it is highly advisable to use the passwd command to change the default password to improve your Pi's security.

Enter passwd on the command line and press Enter. You'll be prompted to enter your current password to authenticate, and then asked for a new password. Press Enter on completion and you'll be asked to confirm it. Note that no characters will be displayed while entering your password. Once you've correctly confirmed your password, you'll be shown a success message (passwd: password updated successfully), and the new password will apply immediately. If your user has sudo permissions, you can change another user's password with password preceded by the user's username.

Figure 14..4 Raspberry Pi Pin Outs

3.2.2 PLC Module (KQ330)

The power line carrier communication (PLC) is a specific communication way of the power systems. Power line carrier communication refers to the technology which uses the existing power lines to transmit analog or digital signal by way of carrier at high speeds. The biggest feature is that the system does not need to rebuild the network, and as long as there is wire, data transmission can be performed.

The current application areas are mainly concentrated in the intelligent home, intelligent utilities (such as remote meter reading system, street lighting remote monitoring systems, etc.) and industrial intelligence (such as various types of devices data acquisition). Technically, power line carrier communication is no longer a point-to-point communications category, but rather to highlight the concept of open network structure. Each control node (controlled device) forms a centralized network. The system uses the existing power lines network, without rearranging network cable, which helps to save financial, material and human resources. At the same time, it is reliable, and it is easy to be implemented and bee extended, therefore, there is the significance for the research of the power line carrier system. Currently, there are three types of international major modulation technology which the high-speed power line carrier communication uses. They are three categories: single-carrier class, spread spectrum class, and OFDM (Orthogonal Frequency Division Multiplexing. The paper analyzed and studied that the FSK-single-carrier class is in the application of the electric power carrier communication. Power line communication has been around for quite some time, but only been used for narrow band tele-remote relay applications, public lighting and home automation. Broadband over PLC only began at the end of the 1990s:

• **1950:** at a frequency of 10Hz, 10kW of power, one-way: town lighting, relay remote control.

• **Mid 1980s:** beginning of research into the use of the electrical grid to support data transmission, on bands between 5 - 500Khz, always in a one-way direction.

• **1997:** first tests for bidirectional data signal transmission over the electrical supply.

Power lines are classified into three types:

• Short range: 0-80km

• Medium range: 80-250km

• Long range: more than 250 km

In our system we use the KQ 330 Module. The advantages of using the KQ 330 Module is that all the components are designed to work with the existing power lines. KQ 330 Modules are widely available, and the range of devices that are available provide a variety of applications that can be achieved using simple plug-in or wire-in modules.

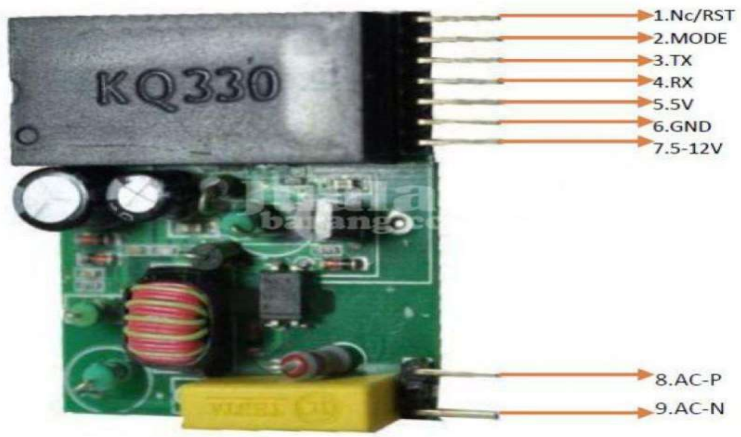


Figure 15.1 The Figure of PLC Module KQ330 Pin Outs

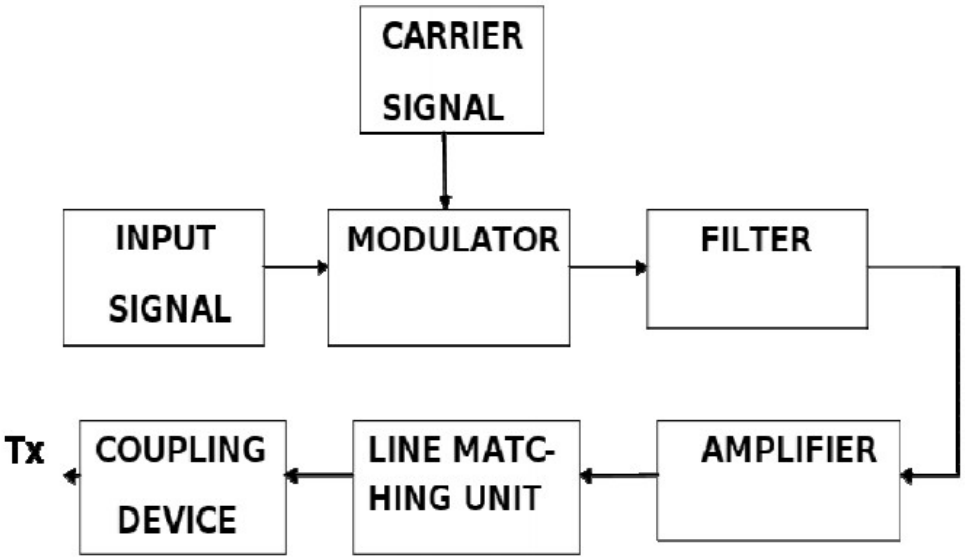


Figure 15.2 Block Diagram of PLC Module KQ330 (Transmitter)

The basic block diagram of the transmitter for data communication using power line carrier communication system is shown in above figure Fig. The existing electrical layout is used to transmit the data or command for the proposed control system from one point towards other without any interference in the electrical signal within the same house. The system can be used to transmit a data signal in the frequency range of 3 KHz to 148.5 KHz. Since we are using a PLC which is a data communication device. The data code generated is modulated using any of the popular modulation techniques and after that it is fed to the amplifier. Later the signal enters to the power line through the interface circuit that includes a resistor and a capacitor i.e. Line matching unit and coupling device. The coupling capacitor is used so that we can couple the 5V signal to the 230V signal so that the circuit will not get disturbed.

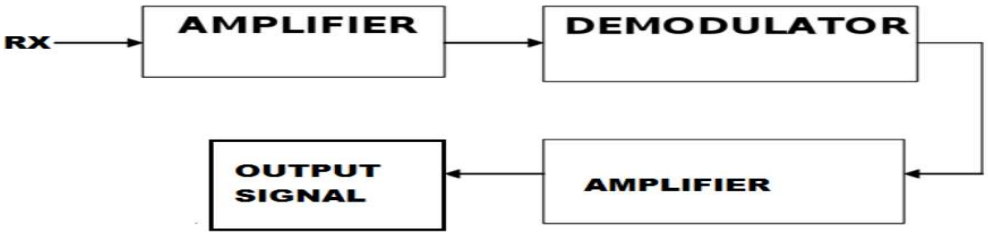


Figure 15.3 Block Diagram of PLC Module KQ330(Receiver)

The basic block diagram of the receiver for data communication using power line carrier communication system is shown in above Fig. The data that is received is first fed to the amplifier to strengthen the weak signal and then it is given to demodulator then we get the original message signal.

3.12.1 OVERALL SYSTEM DESIGN DIAGRAM

The overall design concept of power line carrier communication system is described as the design of power line carrier communication system can be divided into data transmission and data reception according to the data flow. Data transmission flow is as follows: firstly, the system uses the direct interface(serial asynchronous communication) of SCM and FSK-KQ330 module; secondly, after the transmission data is modulated by FSK-KQ330 module, through the external circuit(amplifier circuit and the resonance detection circuit), the square-wave signal changes into the sinusoidal signal; finally, after isolating the interfering signal, the signal is coupled to the power line. The flow of data received is as follows firstly, the resonance detection

circuit detects the received signal secondly, after the signal is isolated by transformer, the waveform is shaped by the resonant circuit; finally, the shaped signal is demodulated by the data module of FSK-KQ330, after the data is demodulated, it is sent back to the microcontroller through the serial ports. In the receiving-data part, it has a zero-crossing detection circuit. The function of the circuit is to detect the frequency of the sine wave signal on the power line. When the level of the signal passes through the zero point, the microcontroller sends or receives data.

The Overall system design diagram signal flow diagram of the carrier module is shown below.

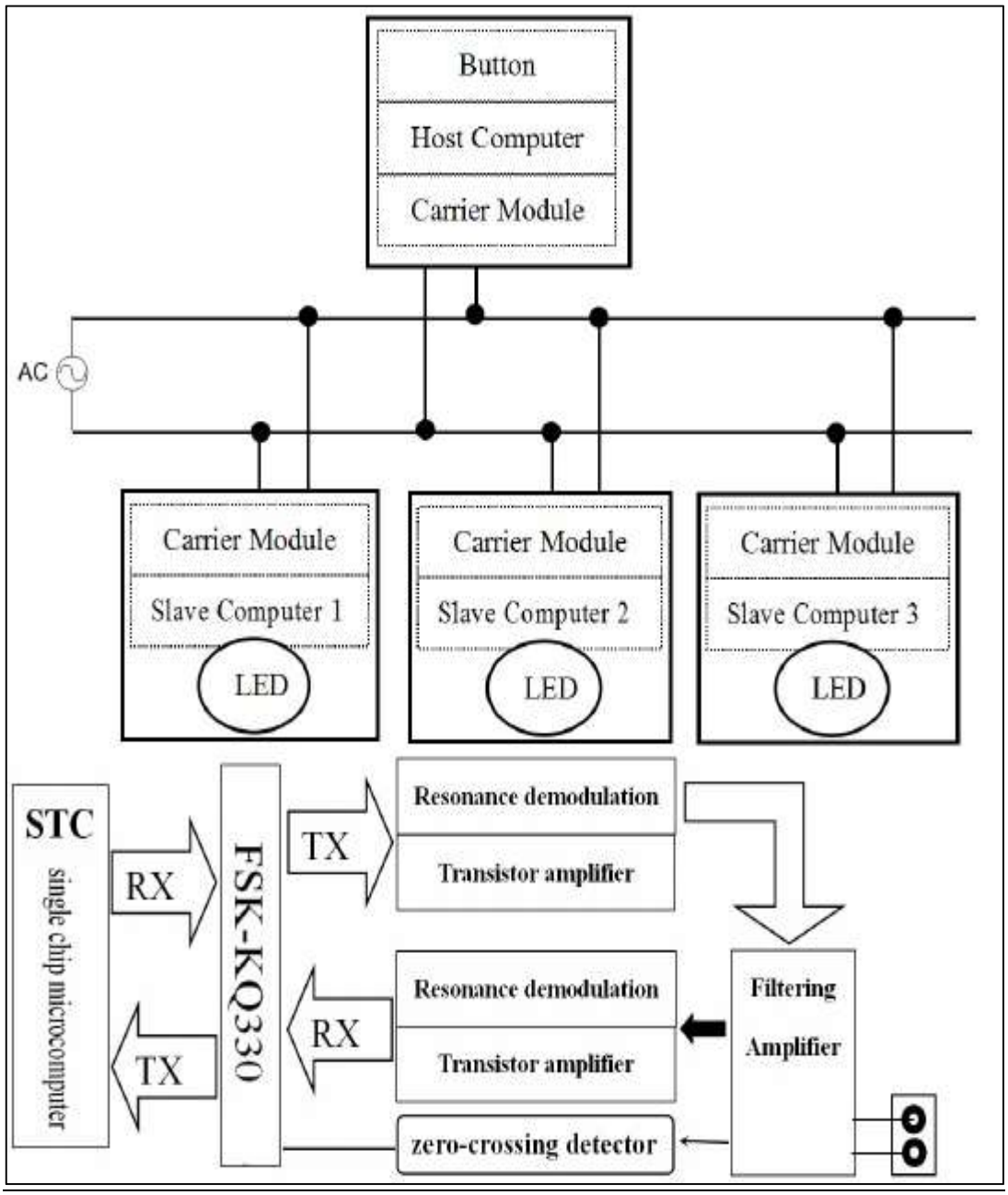


Figure 15.3 Overall system design diagram and signal flow diagram of the carrier module

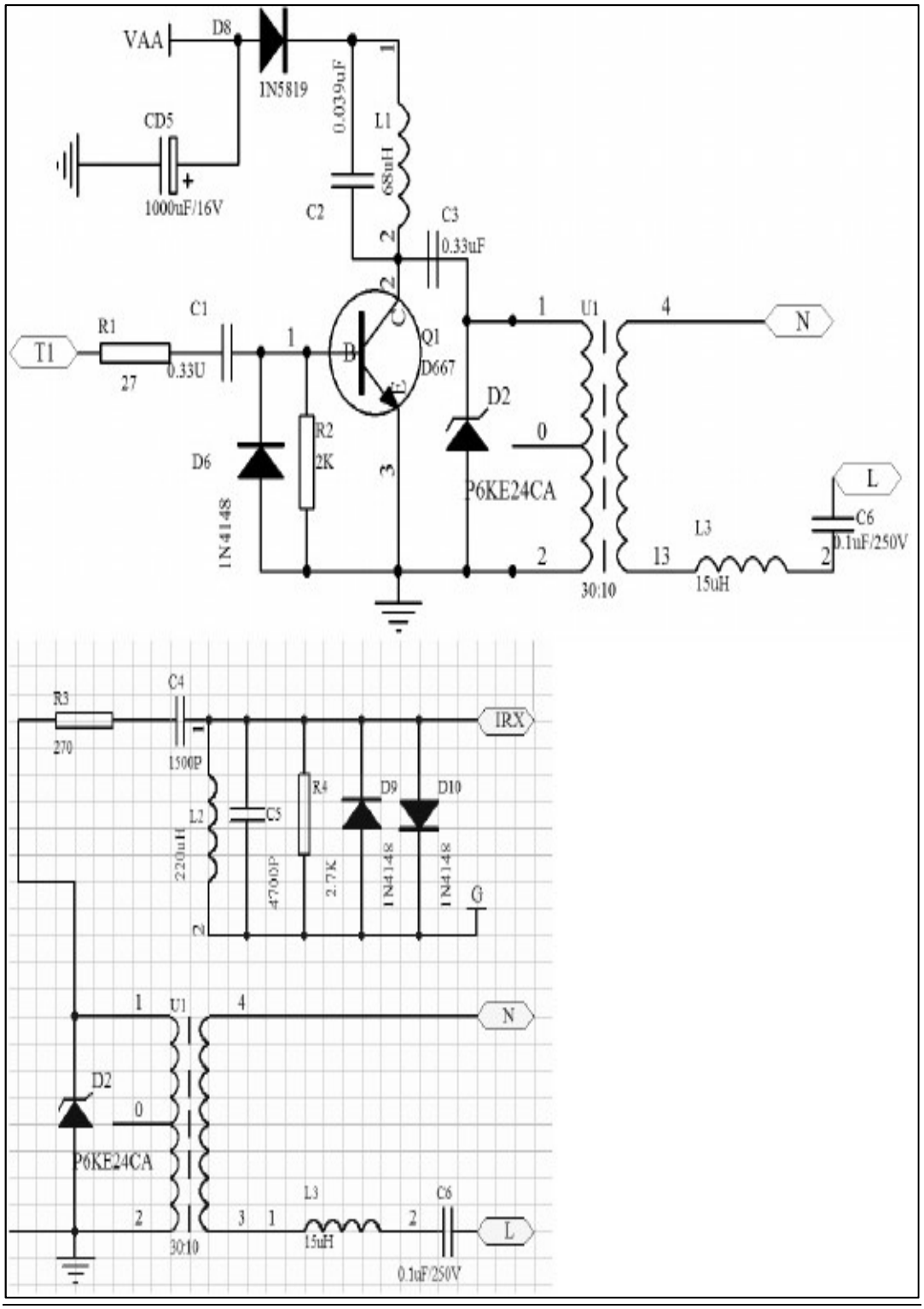


Figure 15.4 Transmitting circuit and Receiving circuit principle diagram

The circuit is mainly includes the magnifying circuit of triodes the resonant circuit and the transformer isolation circuit. The resonant circuit enables waveform signal more stable and no noise.

Circuit analysis

In the power line carrier communication system, the operation of the data transmitting circuit is described as follows: The FSK-KQ330 module's 8 pin outputs the square wave signal, and then it is coupled to the power line, after it is magnified and detected. The role of R1 and C1 is limiting the current. The transistor Q1 amplifies the signal. L1 and C2 constitute a resonant circuit. This role of the circuit is able to change the output square signal form FSK-KQ330 module's 8-pin into sine wave. Then it amplifies the signal from the transistorQ1; the function of the transformer is to isolate the interference and let the current to become lager.

This circuit is mainly includes the magnifying circuit of triodes, the resonance detection circuit, the transformer isolation circuit, and the zero-crossing detection circuit. Receiving circuit is connected to power lines, and it sends the data signal to the module. The main function of the receiving circuit is detection. When the waveform signal is detected and is amplified, FSK-KQ330 module can identify the normal state. The work flow of receiving circuit is described as follows: firstly, the signal in power line enters the receiving pin (1 pin) of FSK-KQ330, after a crossing the peripheral circuits. The function of the peripheral receiving circuit is that the resonant circuit selects frequency. Namely, it uses FSK-KQ330 to identify the signal frequency. After the transformer isolating interrupt signal and the resonant circuit selecting signal frequency and amplifying signal, it uses two reverse diode which filter out the signal of too large magnitude to protect FSK-KQ330 module. Secondly, L3 andC6 constitute the resonance circuit, it can let the wanted signal produce resonance. The role of the resonance circuit is amplifying signal and detecting signal. It is the same as the function of the radios resonant circuit which can extract the waveform of the signal, L2 and C5 also constitute the resonance circuit. Its roles is further amplifying signal and detecting signal to filter out the UN-useful waveform signal. The role of two reverse diode (1N4148) is that limit the waveform amplitude and let it is less than 0.7Vvoltage. Therefore, the circuit can identify the useful waveform and protect the FSK-KQ330 module effectively.

The role of zero-crossing detecting circuit is to detect sine wave in the power line. When the sine wave goes through the zero point, the data signals can be transmitted stably and the waveform amplitude does not change greatly. Zero-crossing detecting circuit is shown below.

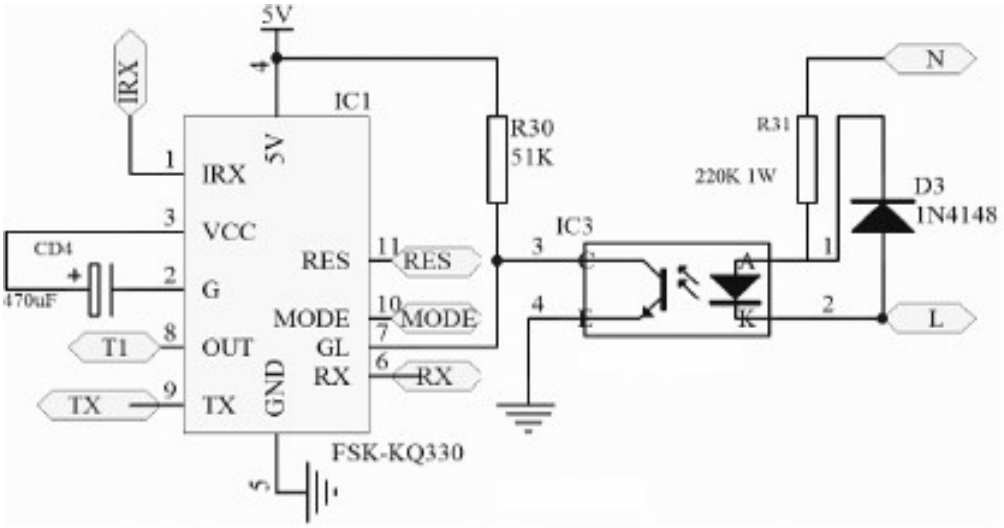


Figure 15.5 Zero-crossing detecting circuit

The module uses low voltage power line as the media of the signal (data)transmission. The carrier frequency of the signal (data) modulated by the module is 50 kHz~350 kHz. The high frequency signal in the low voltage power line can be transmitted to the distance. The 8 pin is the foot of the output data. The operating voltage of the module is +5v.

3.2.3 TEMPERATURE SENSOR

Figure 16.1 Temperature Sensor

In general, a temperature sensor is a device which is designed specifically to measure the hotness or coldness of an object. LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C). With LM35, the temperature can be measured more accurately than with a thermistor. It also possesses low self-heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from -55°C to 150°C.The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It has found its applications on power supplies, battery management, appliances, etc. The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature

(in °C). It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C. The LM35 does not require any external calibration or trimming and maintains an accuracy of +/- 0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The LM35 comes in many different packages such as TO-92 plastic transistor-like package, T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package.

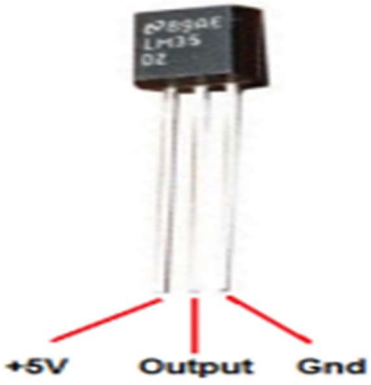


Figure 16.2 Temperature Sensor Pin Outs

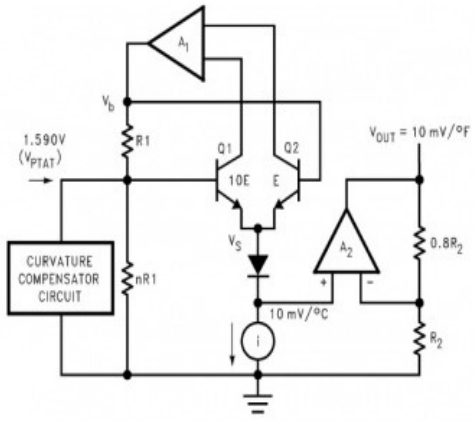


Figure 16.3 Temperature Sensor Internal Circuit

3.2.4 SMOKE SENSOR

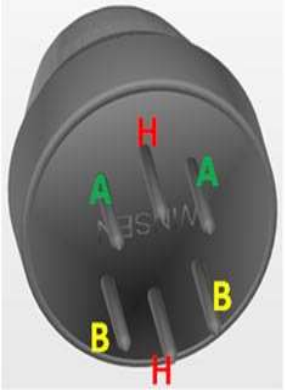
Arduino MQ-2 gas sensor module are used in gas leakage detecting equipment's in family and industry, are suitable for detecting of LPG, i-butane, propane, methane, alcohol, Hydrogen, smoke. The MQ-2 is a flammable gas and smoke sensor detects the concentrations of combustible gas in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of flammable gas of 300 to 10,000 ppm.

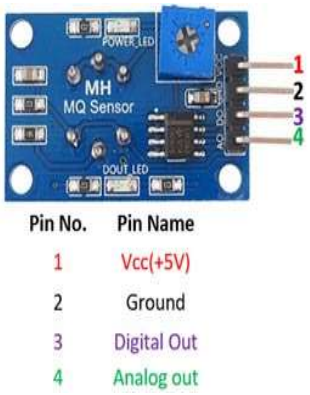
Figure 17.1 Smoke Sensor

The MQ-2 gas sensor is sensitive to LPG, i-butane, propane, methane, alcohol, Hydrogen and smoke. They are used in gas leakage detecting equipment's in family and industry and in portable gas detector.

Specifications of this sensors are

- Detection range: 300 to 10000ppmm
- The characteristics gas: 1000ppmm, isobutane
- Sensitivity: R in air / Rin, typical gas ≥ 5
- Sensing Resistance: 1KΩ 50ppm toluene to 20KΩ in.
- Response time: ≤ 10s
- Recovery time: ≤ 30s
- Heat resistance: 31Ω ± 3Ω
- Heating current: ≤ 180mA
- Heating voltage: 5.0V ± 0.2V
- Heating power: ≤ 900mW
- Measuring voltage: ≤ 24V
- Working conditions of ambient temperature: -20 ℃ ~ +55 ℃
- Humidity: ≤ 95% RH
- Environmental oxygen content: 21%
- Storage conditions Temperature: -20 ° C to +70 ° C
- Humidity: ≤ 70% RH





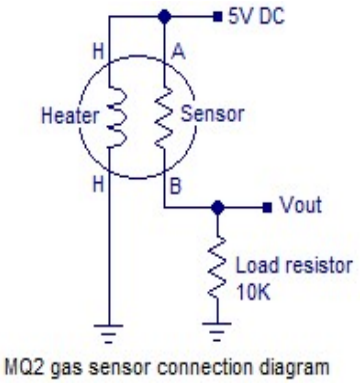


Figure 17.2 Smoke Sensor Pin Outs

Figure 17.3 Smoke Sensor Module Pin Outs

Figure 17.4 Smoke Sensor Internal Circuit

Vcc	This pin powers the module, typically the operating voltage is +5V
Ground	Used to connect the module to system ground
Digital Out	You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer
Analog Out	This pin outputs 0-5V analog voltage based on the intensity of the gas
H -Pins	Out of the two H pins, one pin is connected to supply and the other to ground
A-Pins	The A pins and B pins are interchangeable. These pins will be tied to the Supply voltage.
B-Pins	The A pins and B pins are interchangeable. One pin will act as output while the other will be pulled to ground.

3.2.5 FLAME SENSOR

Figure 18.1 Fire Sensor Module

The flame sensor is used to detect the fire or other light sources which are in the range of wavelength from 760nm to 1100nm. The module consists of an IR sensor, potentiometer, OP-Amp circuitry and a led indicator. When a flame will be detected, the module will turn on its red led. This module is sensitive to flame but it can also detect ordinary light. The detection point is 60 degrees. The sensitivity of this sensor is adjustable, and it also has a stable performance.

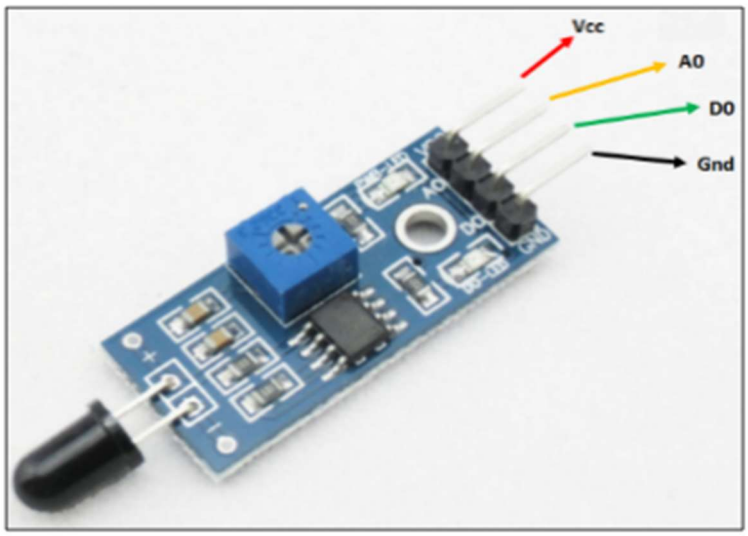


Figure 18.2 Fire Sensor Module Pin Outs

It has both outputs, analog and digital. The analog output gives us a real time voltage output signal on thermal resistance while the digital output allows us to set a threshold via a potentiometer. The operating voltage is from 3.3 – 5V. It gives us both analog and digital output. It has a led indicator, which indicates that whether the flame is detected or not. The threshold value can be changes by rotating the top of potentiometer. Flame detection distance, lighter flame test can be triggered within 0.8m, if the intensity of flame is high, the detection distance will be increased. The detection angle of the flame sensor module is about 60 degrees.

A0: This is the analog pin and this will be connected to the analog pin of the Arduino.

Gnd: This is the ground pin and this will be connected to the ground of the Arduino.

Vcc: This is the input voltage pin of the sensor and this will be connected to the +5V of Arduino.

D0: This is the digital pin and this will be connected to the digital pin of Arduino.

3.2.6 LIGHT SENSOR(LDR)

Figure 19.1 Light Sensor

Photo resistors, also known as light dependent resistors (LDR), are light sensitive devices most often used to indicate the presence or absence of light, or to measure the light intensity. In the dark, their resistance is very high, sometimes up to 1MΩ, but when the LDR sensor is exposed to light, the resistance drops dramatically, even down to a few ohms, depending on the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied and are nonlinear devices. They are used in many applications but are sometimes made obsolete by other devices such as photodiodes and phototransistors. Some countries have banned LDRs made of lead or cadmium over environmental safety concerns. Based on the materials used, photo resistors can be divided into two types; intrinsic and extrinsic. Intrinsic photo resistors use undoped materials such as silicon or germanium. Photons that fall on the device excite electrons from the valence band to the conduction band, and the result of this process are more free electrons in the material, which can carry current, and therefore less resistance. Extrinsic photo resistors are made of materials doped with impurities, also called dopants. The dopants create a new energy band above the existing valence band, populated by electrons. These electrons need less energy to make the transition to the conduction band thanks to the smaller energy gap. The result is a device sensitive to different wavelengths of light. Regardless, both types will exhibit a decrease in resistance when illuminated. The higher the light intensity, the larger the resistance drop is. Therefore, the resistance of LDRs is an inverse, the sensitivity of a photo resistor varies with the light wavelength. If the wavelength is outside a certain range, it will not affect the resistance of the device at all. It can be said that the LDR is not sensitive in that light wavelength range. Different materials have different unique spectral response curves of wavelength versus sensitivity. Extrinsic light dependent resistors are generally designed for longer wavelengths of light,

with a tendency towards the infrared (IR). When working in the IR range, care must be taken to avoid heat build-up, which could affect measurements by changing the resistance of the device due to thermal effects. The figure shown here represents the spectral response of photoconductive detectors made of different materials, with the operating temperature

The most common type of LDR has a resistance that falls with an increase in the light intensity falling upon the device (as shown in the image below). The resistance of an LDR have the resistances: Daylight=5000Ω; Dark=20000000Ω

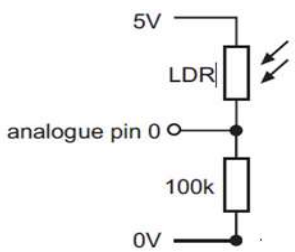


Figure 19.2 Light Sensor Internal Circuit

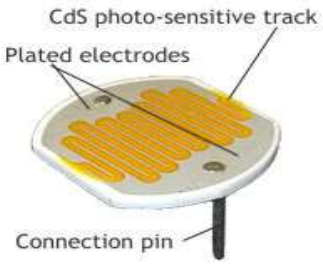


Figure 19.3 Light Sensor Components

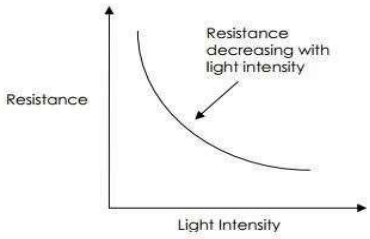


Figure 19.4 Light Sensor Graph

3.2.7 MOTION SENSOR (IR SENSOR)

Figure 20.1 Motion Sensor Module

IR pair is an electronic device which consists of two parts i.) Transmitter and ii.) Receiver. Transmitter is used to transmits or emit the INFRARED rays and the receiver is used simply to receive these radiations. The IR transmitter consists of the LED that emits the IR (InfraRed) radiation. A remote control patterns a flash of invisible light which is turned into an instruction and is received by the receiver module.IR Transmitter and receiver are used to control any device wirelessly, means remotely. TV remote and

TV are the best example of IR transmitter and receiver. TV generally consist TSOP1738 as the IR receiver, which senses modulated IR pulses and convert them into electrical signal. The IR signal is modulated during transmission. Modulation means assigning pattern to the data to be sent to the receiver. The most commonly used IR modulation is about 38khz. R LED emits infrared light, means it emits light in the range of Infrared frequency. We cannot see Infrared light through our eyes, they are invisible to human eyes. The wavelength of Infrared (700nm – 1mm) is just beyond the normal visible light. Everything which produce heat, emits infrared like our human body. Infrared have the same properties as visible light, like it can be focused, reflected and polarized like visible light.

Other than emitting invisible infrared light, IR LED looks like a normal LED and also operates like a normal LED, means it consumes 20mA current and 3vots power. IR LEDs have light emitting angle of approx. 20-60 degree and range of approx. few centimetres to several feets, it depends upon the type of IR transmitter and the manufacturer. Some transmitters have the range in kilometres.

Transmitter is often known as IR LED and the Receiver as IR Sensor.

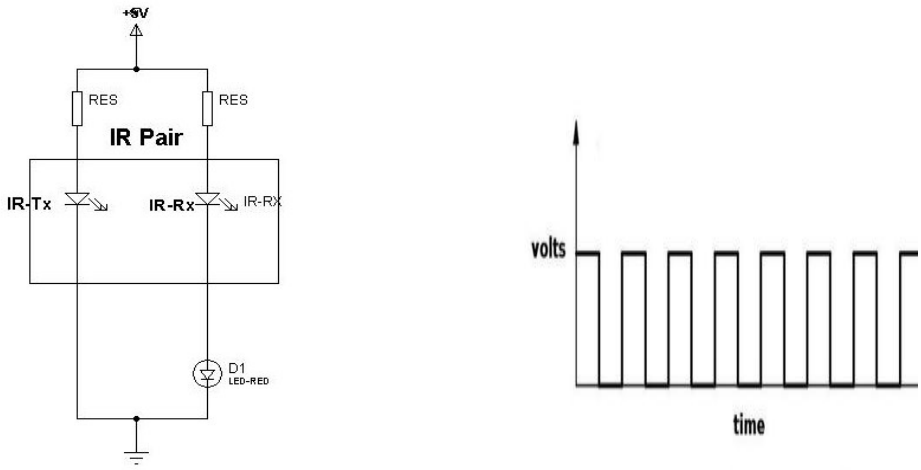


Figure 20.2 Motion Sensor Internal Circuit and Pulses

When you hit a key on your remote, the transmitting IR LED will blink very quickly for a fraction of a second, transmitting encoded data to your appliance.

3.2.8 ADC (MPC3008)

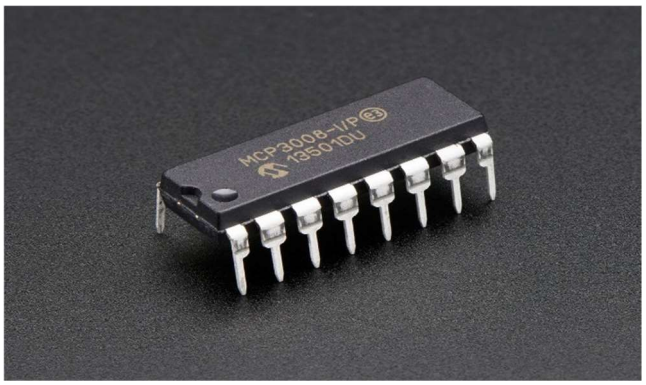


Figure 21.1 ADC

Description

The Microchip Technology Inc. MCP3004/3008 devices are successive approximation 10-bit Analog-to-Digital (A/D) converters with on-board sample and hold circuitry. The MCP3004 is programmable to provide two pseudo-differential input pairs or four single-ended inputs. The MCP3008 is programmable to provide four pseudo-differential input pairs or eight single-ended inputs. Differential Nonlinearity (DNL) and Integral Nonlinearity (INL) are specified at ±1 LSB. Communication with the devices is accomplished using a simple serial interface compatible with the SPI protocol. The devices are capable of conversion rates of up to 200 ksps. The MCP3004/3008 devices operate over a broad voltage range (2.7V - 5.5V). Low-current design permits operation with typical standby currents of only 5 nA and typical active currents of 320 µA. The MCP3004 is offered in 14-pin PDIP, 150 mil SOIC and TSSOP packages, while the MCP3008 is offered in 16- pin PDIP and SOIC packages.

Features

- 10-bit resolution
- ± 1 LSB max DNL
- ± 1 LSB max INL
- 4 (MCP3004) or 8 (MCP3008) input channels
- Analog inputs programmable as single-ended or pseudo-differential pairs
- On-chip sample and hold
- SPI serial interface (modes 0,0 and 1,1)
- Single supply operation: 2.7V - 5.5V
- 200 ksps max. sampling rate at VDD = 5V

- 75 ksps max. sampling rate at VDD = 2.7V
- Low power CMOS technology
- 5 nA typical standby current, 2 µA max.
- 500 µA max. active current at 5V
- Industrial temp range: -40°C to +85°C
- Available in PDIP, SOIC and TSSOP packages

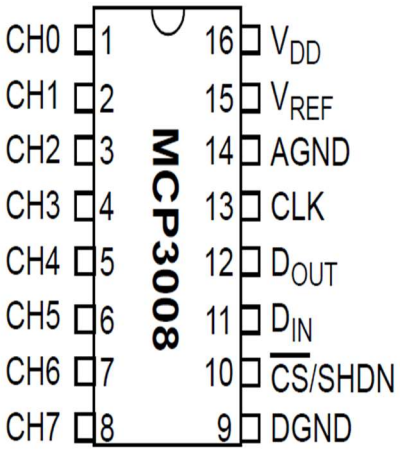


Figure 21.2 ADC Pin Outs

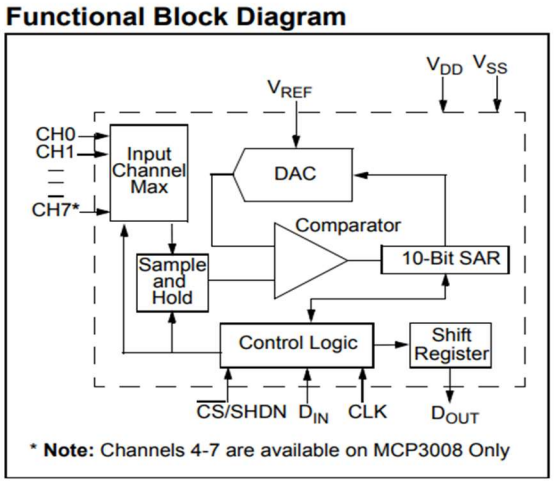


Figure 21.3 ADC Internal Circuit

PIN FUNCTION TABLE

MCP3008 PDIP, SOIC	Symbol	Description
1	CH0	Analog Input
2	CH1	Analog Input
3	CH2	Analog Input
4	CH3	Analog Input
5	CH4	Analog Input
6	CH5	Analog Input
7	CH6	Analog Input
8	CH7	Analog Input
9	DGND	Digital Ground
10	$\overline{CS}$/SHDN	Chip Select/Shutdown Input
11	D_{IN}	Serial Data In
12	D_{OUT}	Serial Data Out
13	CLK	Serial Clock
14	AGND	Analog Ground
15	V_{REF}	Reference Voltage Input
16	V_{DD}	+2.7V to 5.5V Power Supply
–	NC	No Connection

Table 3 ADC Pin Functions

Applications of ADC MPC 3008

- Sensor Interface
- Process Control
- Data Acquisition
- Battery Operated Systems

3.2.9 LCD

Figure 22.1 LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

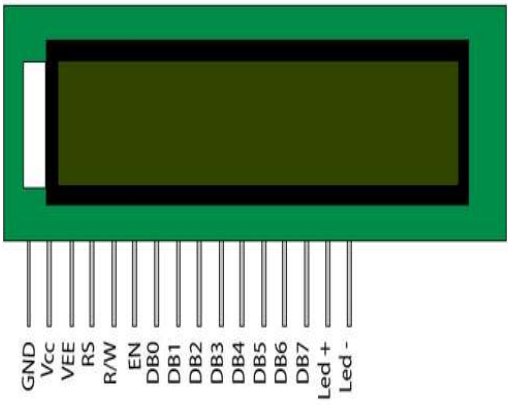


Figure 22.2 LCD Pin Outs

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 4 LCD Pin Functions

Since their interface serial/parallel pins are defined so it’s easy to interface them with many microcontrollers. Many products we see in our daily life have lcd's with them. They are used to show status of the product or provide interface for inputting or selecting some process. Washing machine, microwave, air conditioners and mat cleaners. M denotes number of coulombs and N represents number of rows. Like if the lcd is denoted by 16x2 it means it has 16 coulombs and 2 rows. Few examples are given below. 16x2, 8x1 and 8x2 lcd are shown in the picture below. Note the difference in the rows and coulombs. On a character lcd a character is generated in a matrix of 5x8 or 5x7. Where 5 represents number of coulombs and 7/8 represent number of rows. Maximum size of the matrix is 5x8. You cannot display character greater then 5x8 dimension matrix. Normally we display a character in 5x7 matrix and left the 8th row for the cursor. If we use the 8th row of the matrix for the character display, then their will be no room for cursor.

Lcd's have

- Eight(8) data pins D0-D7
- Vcc (Apply +5 volt here)
- Gnd (Ground this pin)
- Rc (Register select)
- Rw (read - write)
- En (Enable)
- V0 (Set Lcd contrast)

These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

RS(Register select)

A 16X2 LCD has two registers, namely, command and data. The register select is used to switch from one register to other. RS=0 for command register, whereas RS=1 for data register.

Command Register

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen,

setting the cursor position, controlling display etc. Processing for commands happen in the command register.

Data Register

The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. When we send data to LCD it goes to the data register and is processed there. When RS=1, data register is selected.

SL NO	ADDRESS	FUNCTION
1	01	Clear display screen
2	02	Return home
3	04	Decrement cursor (shift cursor to left)
4	06	Increment cursor (shift cursor to right)
5	05	Shift display right
6	07	Shift display left
7	08	Display off, cursor off
8	0A	Display off, cursor on
9	0C	Display on, cursor off
10	0E	Display on, cursor blinking

Table 5 LCD Command Codes

3.2.10 I2C LCD MODULE FOR LCD

Figure 23.1 I2C LCD Module

IC/I2C Interface Adapter Module is used for 16×2 LCD Display. It uses the PCF8574T IC chip which converts I2C serial data to parallel data for the LCD display. Also, this interface module simplifies connecting an Arduino to a 16×2 Liquid Crystal display using only 4 wires These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version, you have check the black I2C adaptor board on the underside of the module. If there 3 sets of pads labelled A0, A1, & A2 then the default address will be 0x3F. If there are no pads the default address will be 0x27. The module has a contrast adjustment pot on the underside of the display. This may require adjusting for the screen to display text correctly. The specifications are Interface: I2C; I2C Address:0x3F; Supply voltage: 5V; Contrast Adjust: Through Potentiometer; Backlight: Blue

LCDs are useful for creating standalone projects. This LCD Display utilizes an I2C interface, which means that fewer pins are necessary to use this product than would be needed with a regular 16x2 LCD Display (just four connections, VCC, GND, SDA & SCL are required). And it is backlit. I2C address is usually decimal 39, hex 0x27. These devices can sometimes be found at decimal 63, 0x3F. It is very easy to find an I2C address on Arduino by using i2c_scanner.

The PCF8574/74A provides general-purpose remote I/O expansion via the two-wire bidirectional I2C-bus (serial clock (SCL), serial data (SDA)). The devices consist of eight quasi-bidirectional ports, 100 kHz I2C-bus interface, three hardware address inputs and interrupt output operating between 2.5 V and 6 V. The quasi-bidirectional port can be independently assigned as an input to monitor interrupt status or keypads, or as an

output to activate indicator devices such as LEDs. System master can read from the input port or write to the output port through a single register. It is used to indicate to the microcontroller that an input state has changed and the device needs to be interrogated without the microcontroller continuously polling the input register via the I2C-bus.The internal Power-On Reset (POR) initializes the I/Os as inputs with a weak internal pull-up 100 micro Amp current source LCDs are useful for creating standalone projects. This LCD Display utilizes an I2C interface, which means that fewer pins are necessary to use this product than would be needed with a regular 16x2 LCD Display (just four connections, VCC, GND, SDA & SCL are required). And it is backlit. I2C address is usually decimal 39, hex 0x27. These devices can sometimes be found at decimal 63, 0x3F. It is very easy to find an I2C address on Arduino by using i2c_scanner.

Figure 23.2 I2C LCD Module Pin Outs

This has 2 I2C serial data pins (SDA & SCL) and so requires far less digital IO pins when controlled from a microcontroller. In total the module only requires 4 wires including 5V power and GND. Contrast adjustment is also provided by the daughter board via a potentiometer.

I2C_LCD is an easy-to-use display module, It can make display easier. Using it can reduce the difficulty of make, so that makers can focus on the core of the work.

We developed the Arduino library for I2C_LCD, user just need a few lines of the code can achieve complex graphics and text display features. It can replace the serial monitor of Arduino in some place, you can get running information's without a computer.

More than that, we also develop the dedicated picture data convert software (bitmap converter) now is available to support PC platform of windows, Linux, Mac OS. Through the bitmap convert software you can get your favorite picture displayed on I2C_LCD, without the need for complex programming.

Features

- Only 2 Arduino pins are occupied (Use I2C interface).
- Supports standard I2C mode (100Kbit/s) and fast I2C mode (400Kbit/s).
- Compatible with multiple communication logic levels: 2.8~5VDC.
- Arduino library supported, use a line of code to complete the display.
- Integrate 7 sizes of ASCII fonts, 5 graphics functions.
- Provide dedicated picture data convert software (Bitmap Converter).
- Most of the complex operation is processed by I2C_LCD independent controller, saving user controller resources.
- Supports cursor function, can set up 16 cursor flicker frequency.
- Supports 128 level backlight lightness adjustment.
- Support 64 level screen contrast adjustment.
- Support device address modification.
- Supports 127 I2C_LCD work in parallel.
- When debugging code, it can take the place of the serial monitor to monitor the program running state.
- Two abnormal recovery methods are provided: reset and restore the factory settings.
- Compatible with Grove interface and 4Pin-100mil interface (under the Grove socket).
- symmetrical fixed hole design for easy user installation.
- China style unique appearance.

3.2.11 BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

Piezoelectric buzzers, or piezo buzzers, as they are sometimes called, were invented by Japanese manufacturers and fitted into a wide array of products during the 1970s to 1980s. This advancement mainly came about because of cooperative efforts by Japanese manufacturing companies. In 1951, they established the Barium Titanite Application Research Committee, which allowed the companies to be "competitively cooperative" and bring about several piezoelectric innovations and inventions.

Figure 24 Buzzer

Piezo buzzers are used for making beeps alarms and tones. They can be used in alarm systems, for keypad feedback, or some games. Light weight, simple construction and low price make it usable in various applications like car/truck reversing indicator, computers, call bells etc.

3.2.12 LED

Light Emitting Diodes (LEDs) are all around us. They are in our homes, our cars, even our phones. LEDs come in a variety of shapes and sizes, this gives designers the ability to tailor them to their product. Any time something electronic lights up, there's a good chance that an LED is behind it. Their low power and small sizes make them a great choice for many different products as they can be worked into the design more seamlessly to make it an overall better device.

Figure 25.1 LED

These are the types of LEDs that are likely to be in your smaller electronics as an indicator light or something of that nature. 5mm LEDs take much less current to run than high brightness LEDs, 20mA compared to a minimum of 350mA for high-power LEDs. If you followed our original Mastering LEDs post, you should know: more current = more light. So obviously these 5mm LEDs are going to be more of an accent light or light for very small spaces. This is exactly the purpose of 5mm LEDs, they can be used together in a large array to create a sign or some sort of matrix, or they can be used on their own to make a small indicator light or one of those tiny key chain flashlights.

Connection is done by connecting the positive of your battery/power source to the Anode and your negative or ground to the Cathode. This will make sure polarity matches up and electricity will flow given you have enough input voltage, lighting up your 5mm LED. If you wire it backwards nothing will happen, and the circuit will remain closed. In making sure you have enough power for your light emitting diode, there are two key ratings you should pay attention to when looking at LEDs specifications: the forward voltage and the forward current. Each LED should list a 'Forward Voltage' that defines the amount of voltage required in order to conduct electricity and produce light. If you try and supply anything less than this amount the LED will remain open and non-conductive. Once the voltage dropped across an LED reaches the forward voltage, your LED will light up. If you have multiple LEDs in series, you must account for the sum of their forward voltage ratings.

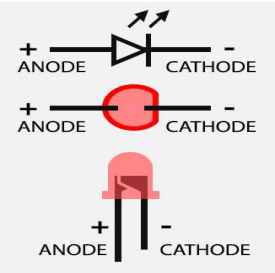


Figure 25.2 LED Internal Circuit

In every other instance you need to limit the amount of current flowing through the LED. With high-power LEDs this is done with a constant current driver. 5mm LEDs current ratings are much lower, usually around 15-30mA, and we can control the current

by placing a resistor in series with the LED. This is where you will hear the term current limiting resistor a lot as the resistor makes sure the current that flows through the circuit is significantly limited. LED wavelength is basically a very precise way of explaining the colour of the light. For LEDs, there will be a variation in colour as the manufacturing process is intense and sometimes there are slightly different wavelengths. On a 5mm LED specification sheet you will actually see a minimum and maximum wavelength. This wavelength is actually determined by the type of semiconductor material used to make the diode inside this 5mm package. The energy band structure of semiconductors varies between materials, so photons are emitted with differing frequencies which effects the light we see. Below is a full table of our LEDs and wavelength options. Some of the more popular colours we sell are Deep Red 660nm, Purple 420nm, Pink 440nm and UV 361nm. 5mm LEDs are a type of LED that hold the die on an anvil post that is encased in an epoxy dome for protection. Connections are then made via the two legs or prongs that come out of the bottom. As we mentioned, a diode only allows flow in one direction. This makes it crucial to differentiate between the positive side (the Anode) and the negative side (the Cathode).

3.2.13 RELAY

Relays are the switches that are open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized.

Figure 26.1 Relay

Electromagnetic Relays are those type of relays which operates on the principle of electromagnetic attraction. It is a type of a magnetic switch which uses the magnet for creating a magnetic field. The magnetic field then uses for opening and closing the switch and for performing the mechanical operation.

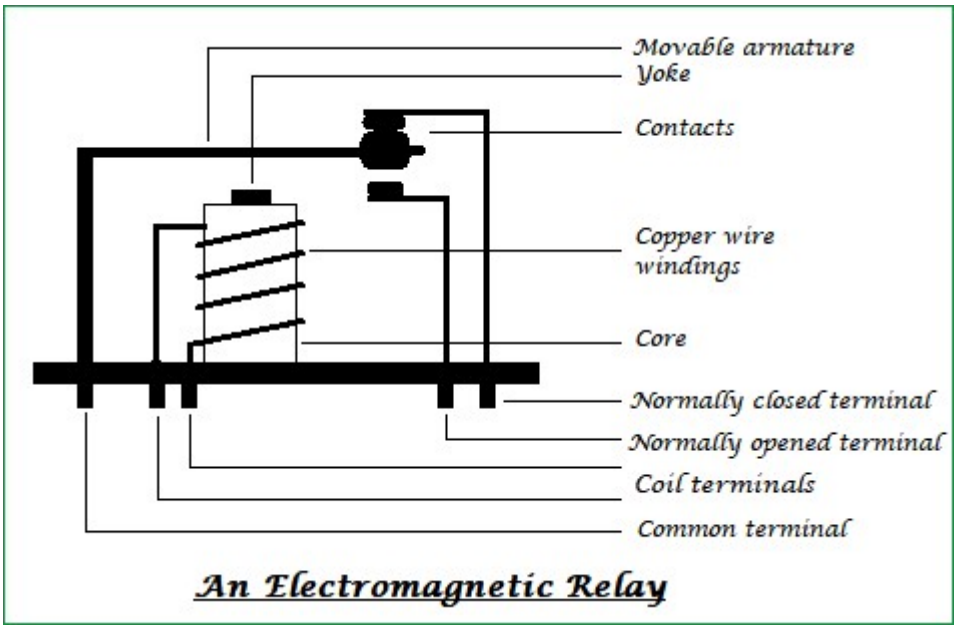


Figure 26.2 Relay Internal Circuit

Electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it).

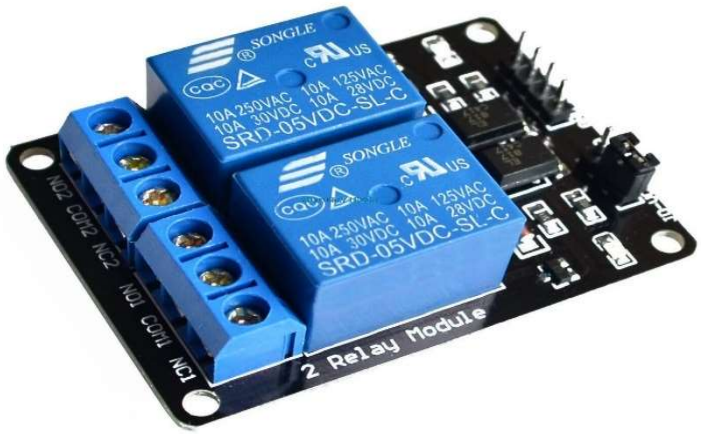


Figure 26.3 Relay Module

A 2-Relay module is designed for a wide range for micro controllers such as the Arduino board, AVR, PIC, ARM, NodeMCU, Raspberrypi,.. e.t.c. with digital outputs. This module incorporates 2 relays. The following forms the relay system:

- **Input:** Vcc, connected to the 5V current on the Arduino Board, GND, connected to the ground and 2 digital inputs. (In1 & In2
- **Output**: The 2-channel relay module could be considered like a series switch: 2 normally Open (NO), 2 normally closed (NC) and 2 common Pins (COM).

*NC- Normally Closed, in which case NC is connected with COM when INT1 is set low and disconnected when INT 1 is high.
*NO- Normally Open, in which case NO is disconnected with COM when INT1 is set low and connected when INT 1 is high.

3.2.14 MOTOR

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and winding currents to generate force in the form of rotation. Electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates in the reverse direction, accepting mechanical energy (such as from flowing water) and converting this mechanical energy into electrical energy.

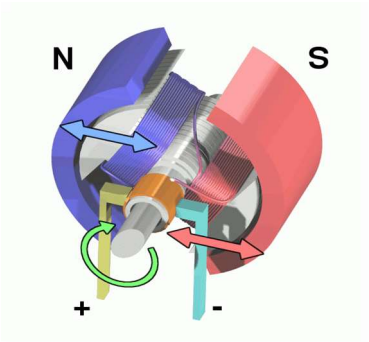


Figure 27.1 Motor Internal

Figure 27.3 DC Motor

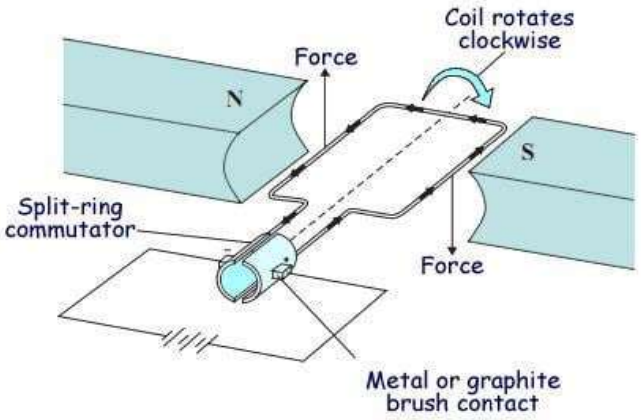


Figure 27.2 Motor Function

Working Principle of DC Motor. A DC motor is an electrical machine which converts electrical energy into mechanical energy. The working of DC motor is based on the principle that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force.

3.2.15 BULB

An LED lamp or LED light bulb is an electric light for use in light fixtures that produces light using one or more light-emitting diodes (LEDs). LED lamps have a lifespan many times longer than equivalent incandescent lamps, and are significantly more efficient than most fluorescent lamps, with some LED chips able to emit up to 303 lumens per watt (as claimed by Cree and some other LED manufacturers).

Figure 28 Bulb

However, LED lamps require an electronic LED driver circuit when operated from mains power lines, and losses from this circuit mean the efficiency of the lamp is lower than the efficiency of the LED chips it uses. The most efficient commercially available LED lamps have efficiencies of 200 lumens per watt (lm/w). Commercially available LED chips have efficiencies of over 220 lm/w.[citation needed] The LED lamp market is projected to grow by more than twelve-fold over the next decade, from $2 billion in the beginning of 2014 to $25 billion in 2023, a compound annual growth rate (CAGR) of 25%. As of 2016, LEDs use only about 10% of the energy an incandescent lamp requires.

Unlike incandescent and CFL bulbs, LED bulbs have moved into the technological age. LEDs that produce white light work in a rather complicated way, and their invention won a Nobel Prize in Physics in 2014! While these are the most efficient bulbs to date, they are not without problems. Although the light they produce looks white, remember that white light contains all the colours of the rainbow. LEDs contain a lot of blue light, too much of which can have negative effects on human health and wildlife.

3.2.16 SOLAR PANEL

Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. A photovoltaic (PV) module is a packaged, connected assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

A solar panel works by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity. Solar panels actually comprise many, smaller units called photovoltaic cells. (Photovoltaic simply means they convert sunlight into electricity.)

Figure 29 Solar Panel

In our project the Solar Panel is using for Fully Automation System which meet crucial requirements of Solar PV Panel operators like constant supervision of the production, maximization of the solar energy yield, real time information about the system status

3.2.17 POWER SUPPLY

Figure 30.1 Power Bank

For having power supply to Raspberry Pi.

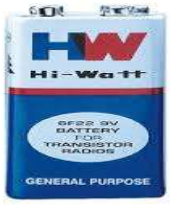


Figure 30.2 Battery

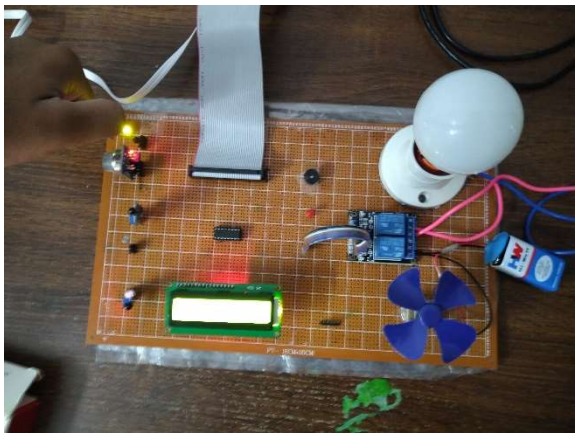
For having power supply for the motor through relay module.

CHAPTER 4

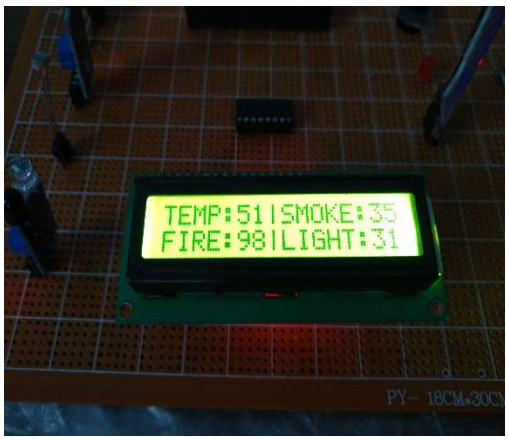
TESTING

Based on the problem concern we have combined both the hardware and software together and developed a prototype model. The code we implemented for this module had been accomplished and verified by programming and testing each of the sensors and then combining all the sub programs to make a complete solution for programming this module. Now the complete working can be explained and understood by the use of pictures shown below

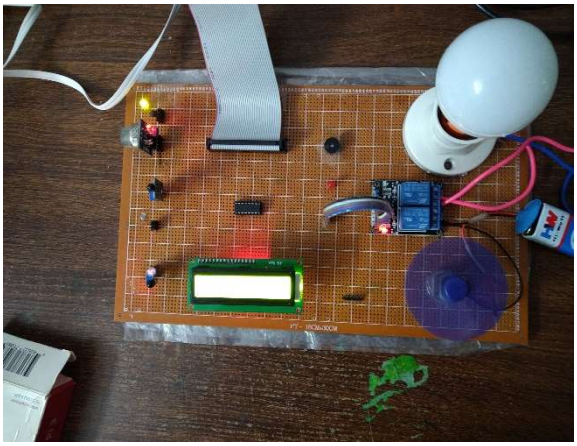
TEMPERATURE (Threshold Value :50)



Simulation of temperature sensor is done by Flame lighter

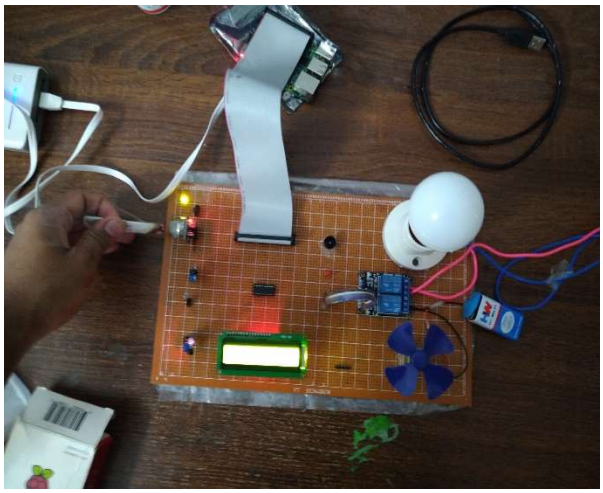


LCD display for monitoring the real time sensor values and temperature value has increased its threshold value 50C



Controlling action is done with help of fan as it switches ON when the temperature value increases from 50C and turns ON buzzer,common LED and gives mobile notification

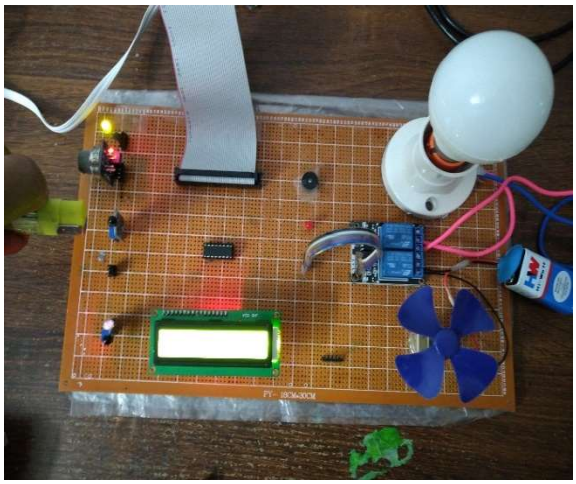
SMOKE (Threshold Value :50)



Simulation of smoke sensor is done by a burnt paper

LCD display for monitoring the real time sensor values and smoke value has increased the threshold value 50ppm

FIRE (Threshold Value :45)

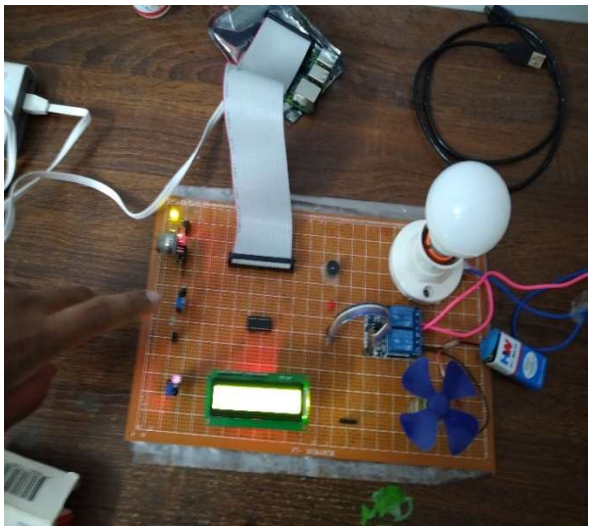


Simulation of fire sensor is done by flame lighter

.

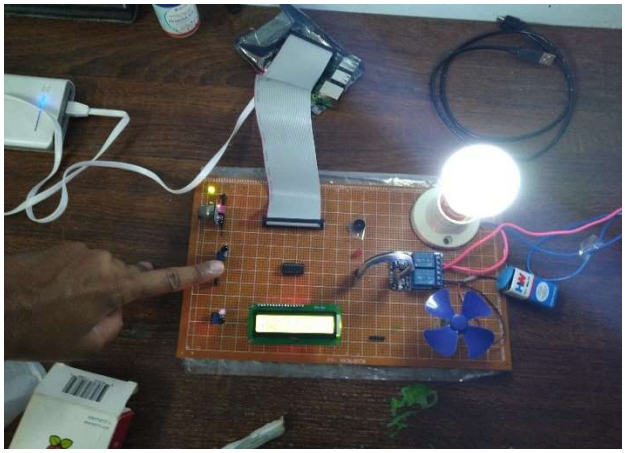
LCD display for monitoring the real time sensor values and fire values has decreased its threshold value 45

LIGHT (Threshold Value :25)



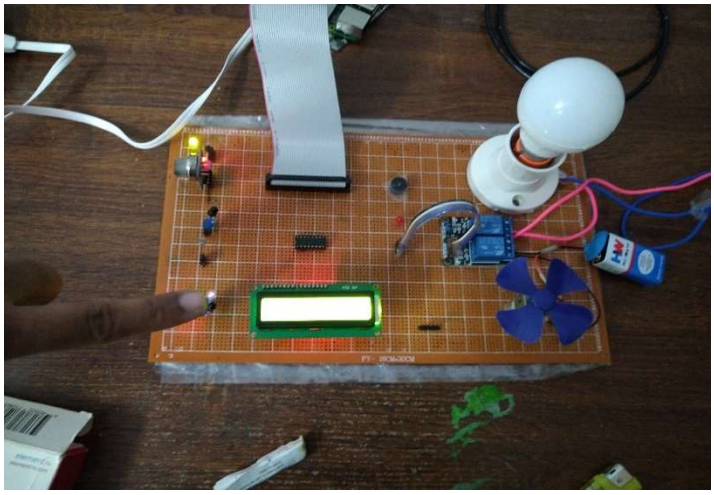
Simulation of light sensor is done by hand

LCD display for monitoring the real time sensor values and light value has decreased its threshold value 25 lm



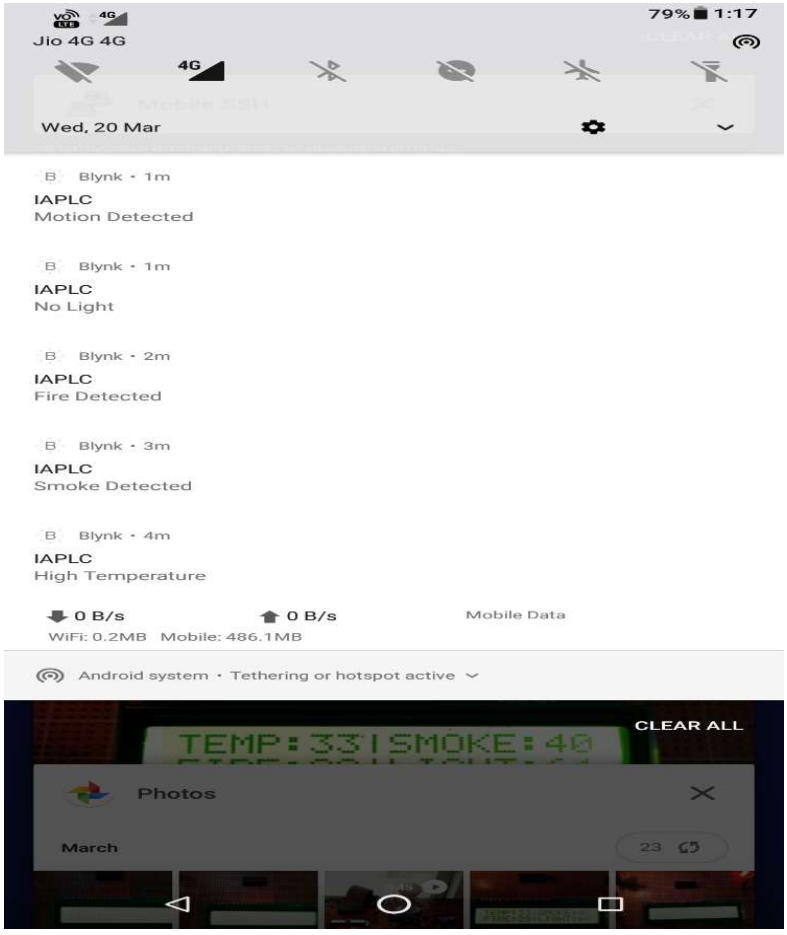
Controlling action is done with help of bulb as it switches ON when the light value decreases from 25 lm and turns ON buzzer,common LED and gives mobile notification

MOTION (Threshold Value :45)



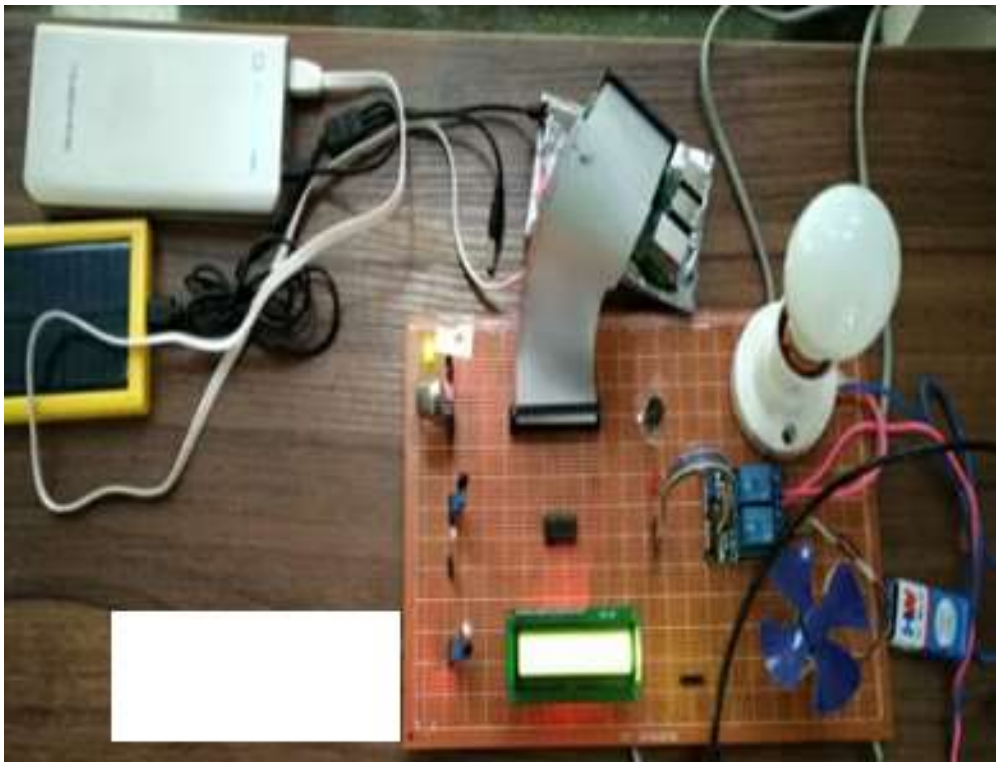
Simulation of motion sensor is done by hand and turns ON buzzer, common LED when it decreases its threshold value from 45

MOBILE NOTIFICATIONS



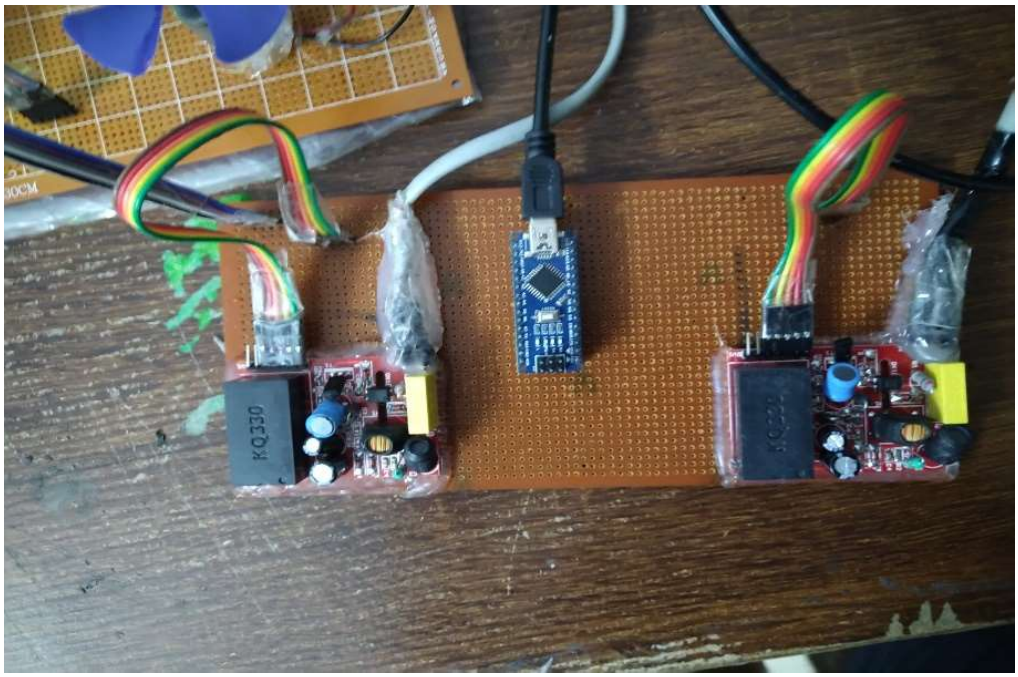
When any sensor value has crossed its threshold, value produces instant notification to the mobile

INDUSTRIAL AUTOMATION

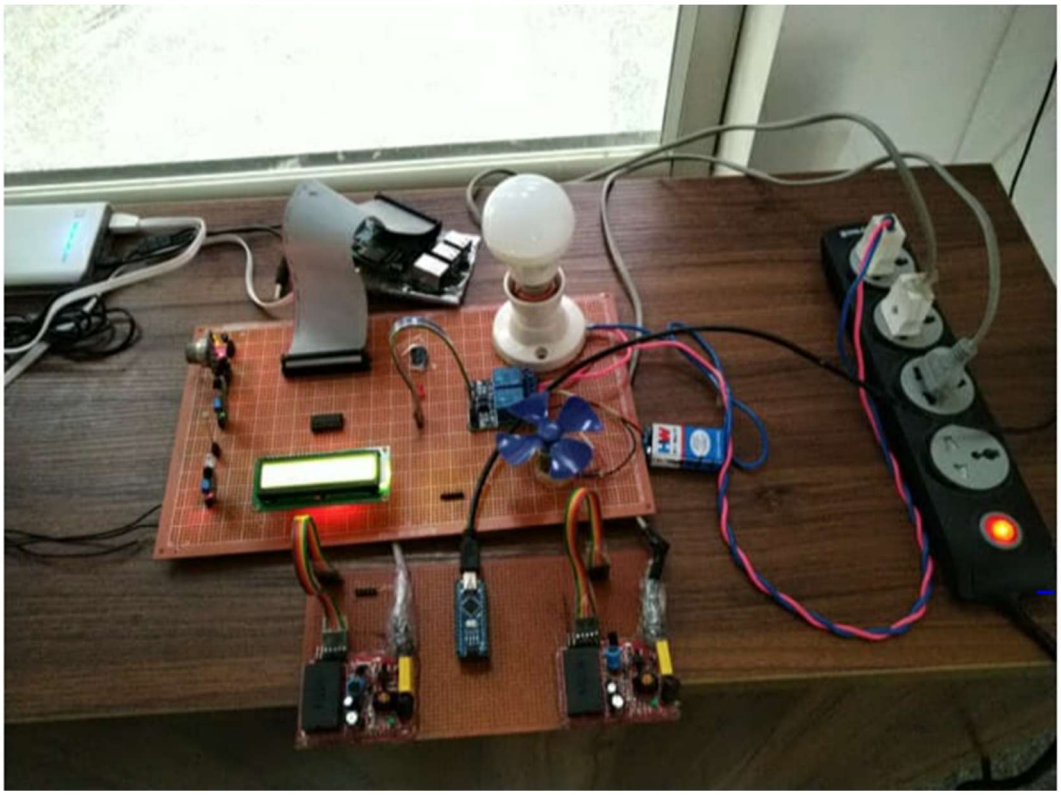


Complete setup of Industrial Automation

POWER LINE COMMUNICATION `



Complete setup of Power Line Communication



Complete setup of Industrial Automation and Power Line Communication

CHAPTER 5
TEST RESULT

MOBILE SSH TERMINAL

Terminal used in mobile for connecting to Raspberry Pi by providing its IP Address and port number in its configuration menu

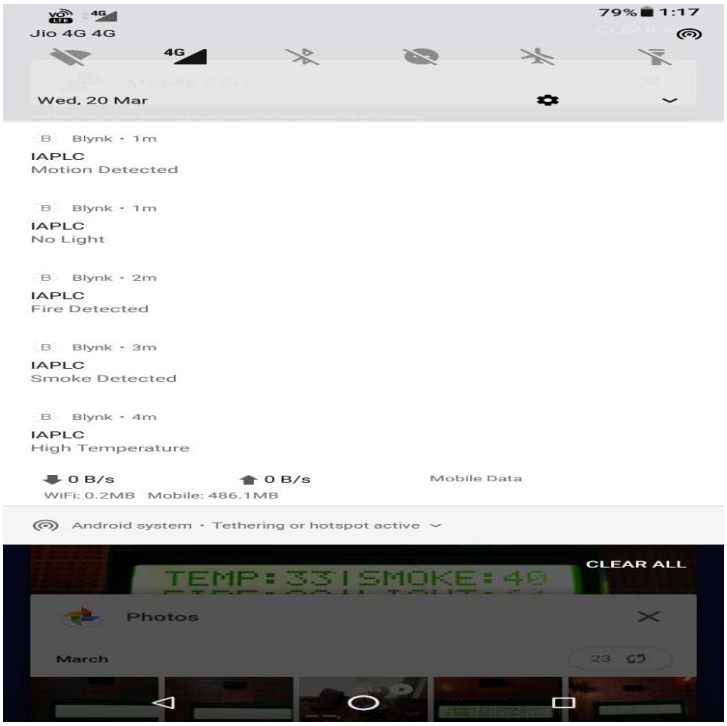
LCD DISPLAY

Displays the real time value of each sensor

BLYNK DASHBOARD:

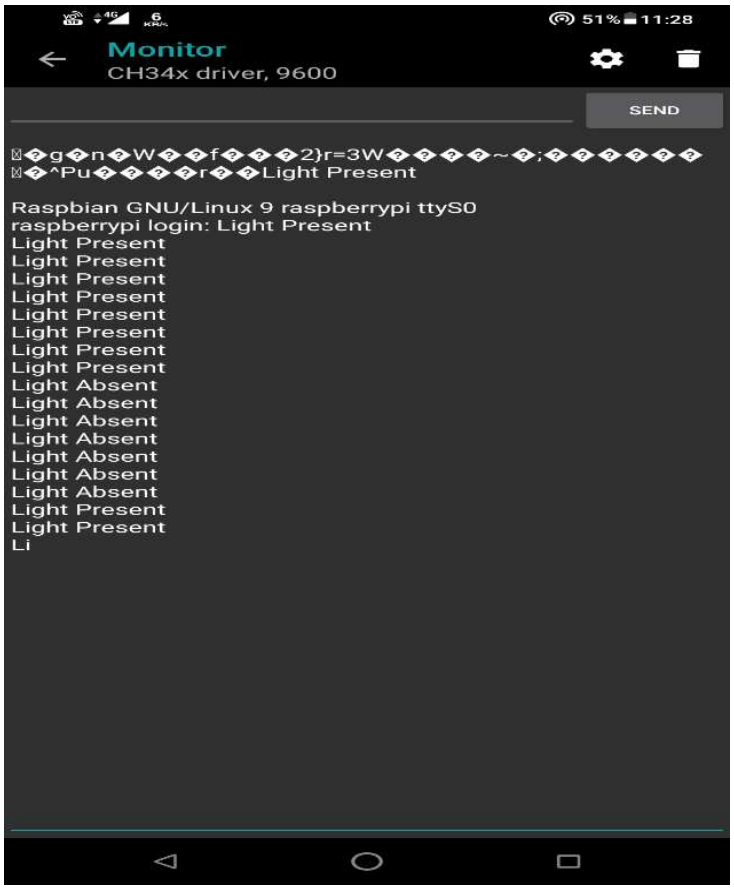
Shows the real time values of all sensors in form of graphical dashboard

MOBILE NOTIFICATION



When any sensor value has crossed its threshold value produces instant notification to the mobile

SERIAL MONITOR MOBILE



Shows the values that are received by Arduino Nano serial communication for Power Line Communication

CHAPTER 6

CONCLUSION

6.1 CONCLUSION

We improve this project by implementing this project to add more sensors and make it more accurate and control more number of parameters by using the IOT. In this competitive world of industrial sectors all factories have been modernized using automation. The industrial automation has played an important role in our projects we have suggested an innovation proposal which will take Automation Monitoring in industries. The proposed model of System has several distinct advantages over the existing technology. They handle large amount of data, monitor the power consumption and internal parameters Temperature, Smoke, Fire, Light and Motion Detection with the help of sensor network and Raspberry pi, we successfully implemented the Power Line communication between PLC transmitter and PLC Receiver. Power Line Communication also play an important role in the system.

6.2 FUTURE SCOPE

Since the turn of the century, the global recession has affected most businesses, including industrial automation. After four years of the new millennium, here are my views on the directions in which the automation industry is moving. Automated factories and processes are too expensive to be rebuilt for every modification and design change – so they have to be highly configurable and flexible. To successfully reconfigure an entire production line or process requires direct access to most of its control elements – switches, valves, motors and drives down to a fine level of detail.

In industries, there would be a set of technologies that are implemented to get the desired performance or output, making the automation systems most essential for industries. On the other hand, industrial automation involves usage of advanced control strategies such as cascade controls, control hardware devices and other instruments for sensing the control variables etc.

In industries, there would be a set of technologies that are implemented to get the desired performance or output, making the automation systems most essential for industries. On the other hand, industrial automation involves usage of advanced control strategies such as cascade controls, control hardware devices and other instruments for sensing the control variables etc.

This has been designed to monitor and handle the machines automatically even if there are less or no workers available. The number of machines which are to be automated are yet to be added. Every change should be intimated to the server and there should be a display regarding the work which is being done. We improve this project by implementing this project to add more sensors and make it more accurate, and control more number of parameter. We have made the prototype of Industrial Automation And Power Line Communication with reference to practical real time problems faced by the industries and can be resolved by implementing this in Industries. This prototype model can be used to monitor the industrial parameters individually due to this it requires more manpower and time to monitor them continuously where maintaining such procedure is very difficult and any misinterpretation occurs than that may lead a huge loss to the industry.

The advantages are as follows

- Reliable and Long Lasting
- Portable
- Low Power
- Low Manpower
- Compact Design
- Continuous Monitoring
- More number of parameters can be monitored
- Green Energy Usage
- Faster Alerts
- Instantaneous Controlling

CHAPTER 7

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8. https://zeroohm.com/blogs/tutorials
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15. https://www.instructables.com/id/Raspberry-Pi

CHAPTER 8
APPENDIX

8.1 CODE

INDUSTRIAL AUTOMATION

```
#Import Libraries

import BlynkLib
import time
import RPi.GPIO as GPIO ##GPIO
library
import time
import I2C_LCD_driver
import Adafruit_GPIO.SPI as SPI
import Adafruit_MCP3008
GPIO.setmode(GPIO.BOARD)
GPIO.setup(36,GPIO.OUT)
GPIO.setup(35,GPIO.OUT)
GPIO.setup(32,GPIO.OUT)

#Software SPI configuration (ADC)
CLK  = 18
MISO = 23
MOSI = 24
CS   = 25
mcp =
Adafruit_MCP3008.MCP3008(clk=CLK,
cs=CS, miso=MISO, mosi=MOSI)

#LCD Initialization
mylcd = I2C_LCD_driver.lcd()
mylcd.lcd_display_string("INDUSTRIA
L",1,3)
mylcd.lcd_display_string("AUTOMATI
ON   PLC",2,0)
time.sleep(4)
mylcd.lcd_display_string("TEMP:",1,0)
mylcd.lcd_display_string("SMOKE:",1,8
)
mylcd.lcd_display_string("FIRE:",2,0)
mylcd.lcd_display_string("LIGHT:",2,8)
mylcd.lcd_display_string("|",1,7)
mylcd.lcd_display_string("|",2,7)
# Hardware SPI configuration (ADC)
SPI_PORT   = 0
SPI_DEVICE = 0
mcp=Adafruit_MCP3008.MCP3008(spi=
SPI.SpiDev(SPI_PORT, SPI_DEVICE))
print('Reading MCP3008 values, press
Ctrl-C to quit...')

#Blynk Authentication  Token
BLYNK_AUTH =
'26d0f1db030d445593af98eef1c445b5'
# Initialize Blynk
blynk =
```

```
BlynkLib.Blynk(BLYNK_AUTH)

while True:
#Temperature Sensor Configuration
  t1=mcp.read_adc(0)
  t2=(t1*500)/1024
  t=(int(t2)-20)

  if t<=38:
   GPIO.output(35,0)
   GPIO.output(36,1)
  else:
   blynk.notify("High Temperature")
   GPIO.output(35,1)
   GPIO.output(36,0)
  print "Temperature:",t
  mylcd.lcd_display_string("%d"%t,1,5)
  blynk.virtual_write(3,t)
  time.sleep(0.5)

#Smoke Sensor Configuration
  s1=mcp.read_adc(1)
  s2=(s1*500)/1024
  s=(int(s2*0.2))
  if s<=85:
   GPIO.output(35,0)
  else:
   blynk.notify("Smoke Detected")
   GPIO.output(35,1)
  print "Smoke:",s

mylcd.lcd_display_string("%d"%s,1,14)
  blynk.virtual_write(4,s)
  time.sleep(0.5)

#Fire Sensor Configuration
  f1=mcp.read_adc(2)
  f2=f1*0.1
  f=(int(f2)-1)
  if f<=45:
   GPIO.output(35,1)
   blynk.notify("Fire Detected")
  else:
   GPIO.output(35,0)
  print "Fire:",f
  blynk.virtual_write(5,f)
  mylcd.lcd_display_string("%d" %f,2,5)

  time.sleep(0.5)

#Light Sensor Configuration
  l1=mcp.read_adc(3)
  l2=l1*0.1
  l=(int(l2)+20)
  if l<=25:
   blynk.notify("No Light")
   GPIO.output(35,1)
   GPIO.output(32,0)
  else:
   GPIO.output(35,0)
   GPIO.output(32,1)
  print "Light:",l
  blynk.virtual_write(6,l)
```

```
   mylcd.lcd_display_string("%d"
%l,2,14)
   time.sleep(0.5)
```

#IR Sensor Configuration

```
   m1=mcp.read_adc(4)
   m2=m1*0.1
   m=(int(m2))
   if m<=45:
    blynk.notify("Motion Detected")
    GPIO.output(35,1)
   else:
    GPIO.output(35,0)
   print "Motion:",l
   blynk.virtual_write(7,m)
```

POWER LINECOMMUNICATION

```
import serial
import RPi.GPIO as GPIO
import os, time
import Adafruit_GPIO.SPI as SPI
import Adafruit_MCP3008
#CLK  = 18
#MISO = 23
#MOSI = 24
#CS   = 25
#mcp = Adafruit_MCP3008.MCP3008(clk=CLK, cs=CS, miso=MISO, mosi=MOSI)
SPI_PORT   = 0
SPI_DEVICE = 0
mcp = Adafruit_MCP3008.MCP3008(spi=SPI.SpiDev(SPI_PORT, SPI_DEVICE))
#print('Reading MCP3008 values, press Ctrl-C to quit...')
port = serial.Serial("/dev/ttyS0", baudrate=9600, timeout=0.5)
while True:
        t1=mcp.read_adc(3)
        if (t1>=50):
                port.write('Light Present \n')
      else:
                port.write('Light Absent \n')
        print (t1)
        time.sleep(1.25)
```