Internet of Things Workshop
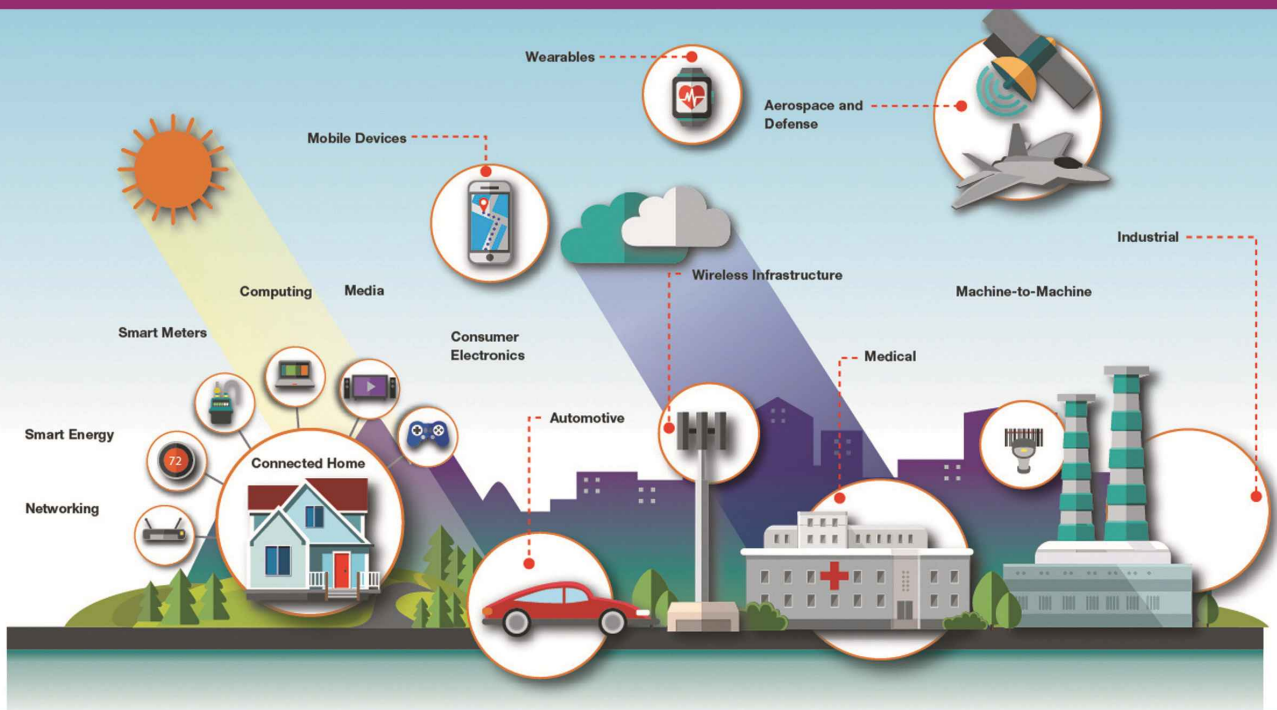
- Wearables
- Aerospace and Defense
- Mobile Devices
- Computing
- Media
- Smart Meters
- Consumer Electronics
- Wireless Infrastructure
- Machine-to-Machine
- Industrial
- Smart Energy
- Automotive
- Medical
- Networking
- Connected Home
- 72

Vi Microsystems Pvt. Ltd.,

INTERNET OF THINGS (IoT) - ECONOMIC SOLUTION

We have known the Internet to connect people and enable them to share information, mainly in the form of text, photographs and videos. Now, it has evolved to connecting physical objects as well. It's going towards connected cars, smart homes, connected wearables, smart cities and connected healthcare.

Why we need IoT Gateway?

A ubiquitous Internet of Things (IoT) depends upon wireless connectivity, but there are many options for wireless and not every device is IP addressable a requisite feature for IoT. What's more, RF design is inherently difficult.

Hence ,we need the IP Addressable IoT Gateway, which can communicate with different wireless protocols based devices and cloud platform.

An IoT system has number of functional blocks. We have implemented the IoT development system based on the below functional blocks, such as,

1. Identifying the Devices
2. Establishing the Communication between Different wireless based devices
3. Sensing & Actuating the Engineering devices.
4. Controlling the Devices with or without Gateway
5. Sending the Data to cloud server
6. Data Analytics
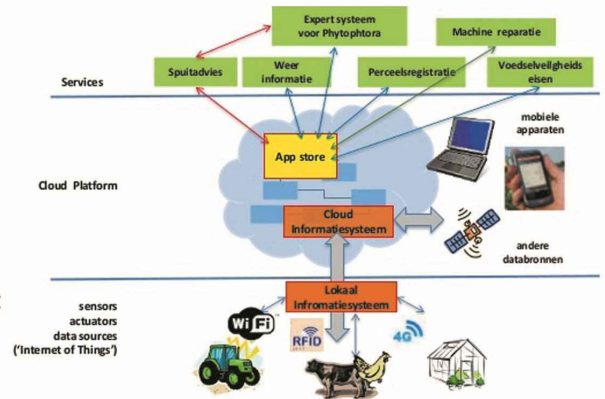
An efficient IoT Development system can facilitate a better platform to the students to innovate and implementing their own ideas. Hence, we offer a better IoT Development platform, which have different types of reprogrammable wireless end devices, Linux based Gateway to understand the IoT concepts and develop their own IoT Applications.
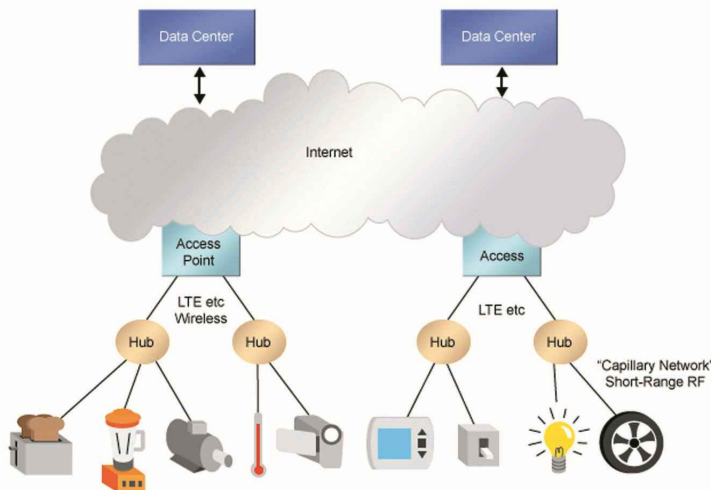
Challanges to build an IoT System

* Mobility
* Reliability
* Scalability
* Management
* Availability

Every where Open source

Nowadays most educationalist prefer to work with Open source software, because of its,

1. Efficiency
2. Interoperability
3. Innovation

Hence, we have implemented the IoT Platform using the open source softwares and the IoT devices can speak

1. Bluetooth Sensor Node
* Bluetooth Specification Version 4.1
* Can be interface with MCU
* ASCII Command interface over API
* Firmware upgrade over UART or OTA
* 64KB Internal serial flash
* 3 channel ADC

2. WiFi Sensor Node
* API or AT command configuration
* 4 Channel ADC with 10 bit resolution
* 802.116b/g/n standard
* 1Mbps data rate
* Upto 309mA Transmit current

3. ZigBee Sensor Node
* API or AT command configuration
* 4 Channel ADC with 10 bit resolution
* 802.15.4 protocol
* 250Kbps data rate
* 35mA Transmit current

4. IoT Gateway
* Third Generation Raspberry Pi
* 1.2GHz, 64bit quad core Cortex A53 CPU
* Bluetooth 4.1 Classic BLE
* 2.4GHz, 802.11 Wireless (wifi)
* 1GB internal RAM
* 4 USB & 1 HDMI ports
* Ethernet port 10/100µbps

5. TI Sensor Tag
* 10 low-power sensors
* ARM® Cortex®-M3 CC2650 wireless MCU
* Operated by coin cell battery
* Cloud connectivity via Bluetooth®

6. GSM Module
* Quad Band   : GSM/EGSM/DCS/PGS@880/900/1800/1900MHz
* GPRS Connectivity : GPRS Multy-slot class 10
* GPRS Data rate   :
         UP Link   : 42.8 kbps
         DN Link   : 85.6 kbps
* Fax   : Group 3 class 1
* Sim Interface   : 1.8V & 3V Sim cards Support
* O/P RF power   : 1W-DCS/PCS, 2W-GSM/EGSM
* Host Interface   : UART@9600bps - RS232
* Audio Interface : MIC, Headphone
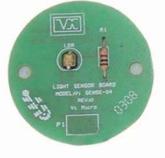* Other Interface : ADC, GPIO & I2C

7. SENSORS

Temperature Sensor
* Sensor : LM35
* Precision Temperature Sensor Calibrated directly in ° Celsius
* Rated for full +2° to +150°C range
* Analog Output

Light Sensor
* Sensor : LDR
* Analog output : 0 - 3.3V
* It detects any light source
* Wide Spectral response

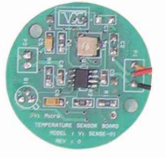### # Smoke Sensor
* Sensor : MQ-II
* Good sensitivity to Combustible gas in wide range
* High sensitivity to LPG, Propane and Hydrogen

Humidity Sensor
* Sensor : HIH4030
* Near linear voltage output Vs %RH
* Typical 1 to 3.6 Volt DC output for 0 to 100% RH at 5V DC supply

List of Experiments :-

1. Programming different wireless IoT devices, based on
    a. Smart Bluetooth Protocol
    b. WiFi Protocol
    c. Zigbee Protocol
2. Controlling LED via wifi communication.
3. Monitoring the temperature level and Alert via SMS.
4. Sensors data Logging
5. Implementing IoT Based Smart Home Automation system.
6. Controlling Motors using Actuation Application
7. Integrating IoT Devices with Thing Speak IoT Platform
8. Integrating Different wireless protocols based IoT End devices with IoT Gateway
9. Configuring IoT Gateway for WiFi, Bluetooth, Zigbee protocol communication
10. Installing Web server ,Database Server in IoT Gateway
11. Interfacing different type of sensors with IoT End Devices
12. Graph representation of sensor data
13. Interfacing IoT Gateway with sensor bag via Bluetooth protocol, which contains bunch of sensors.
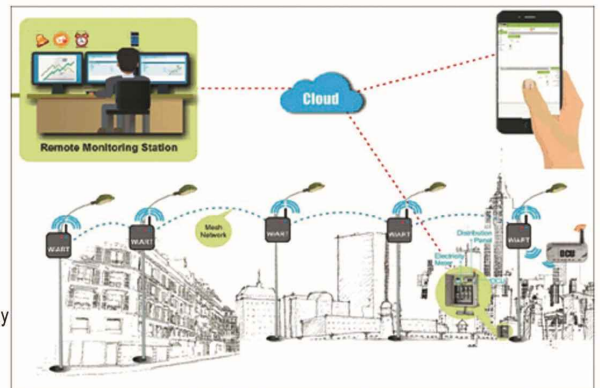
About Internet of Things

Internet technology provides a good way for us to develop an integrated computing network environment, The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and Other items embedded with electronics, software sensors actuators and network connectivity which enable these objects to collect and exchange data Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing internet infrastructure. Experts estimate that the IoT will consist of about 30 billion objects by 2020.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure,[creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber – a physical systems cyber-physical system which also encompasses technologies such as smart grids, virtual power plant, smart home, intelligent transportation and smart cities.

"Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters,[automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring,[or field operation devices that assist firefighters in search and rescue operations. Legal

scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service".

These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. The quick expansion of Internet-connected objects is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. In recent years with the massive growth in global cyber threat, there has been a significant rise in exploitation of IoT technologies for committing cyber terror crimes.

Introduction of Raspberry pi 3

It is a third generation of Raspberry pi 3 model. It is based on a Broad com BCM2837 chip.SD card is used for long term storage and booting. 40 pins are in this Raspberry pi 3 model pin diagram. SD card is the heart of the Raspberry pi 3. Quad core is used in the Raspberry pi 3. It has 64 bit and 1.2 GHz clock speed (Roughly 50% faster than pi 2). Raspberry pi 3 has 1GB RAM.

The Raspberry Pi 3 model is a small, powerful and lightweight ARM based computer which can do many of the things a desktop PC can do. It was developed in the UK by the Raspberry Pi Foundation with the hope of inspiring a generation of learners to be creative and to discover how computers are programmed and how they function. It is a standalone Linux, BSD, RISC OS, or Plan 9 system with a lot of I/O. The powerful graphics capabilities and HDMI video output make it ideal for multimedia applications such as media centers and narrow casting solutions. The Raspberry Pi is based on a Broadcom BCM2837 chip. It does not feature a built-in hard disk or solid-state drive, instead relying on an SD card for booting and long-term storage.
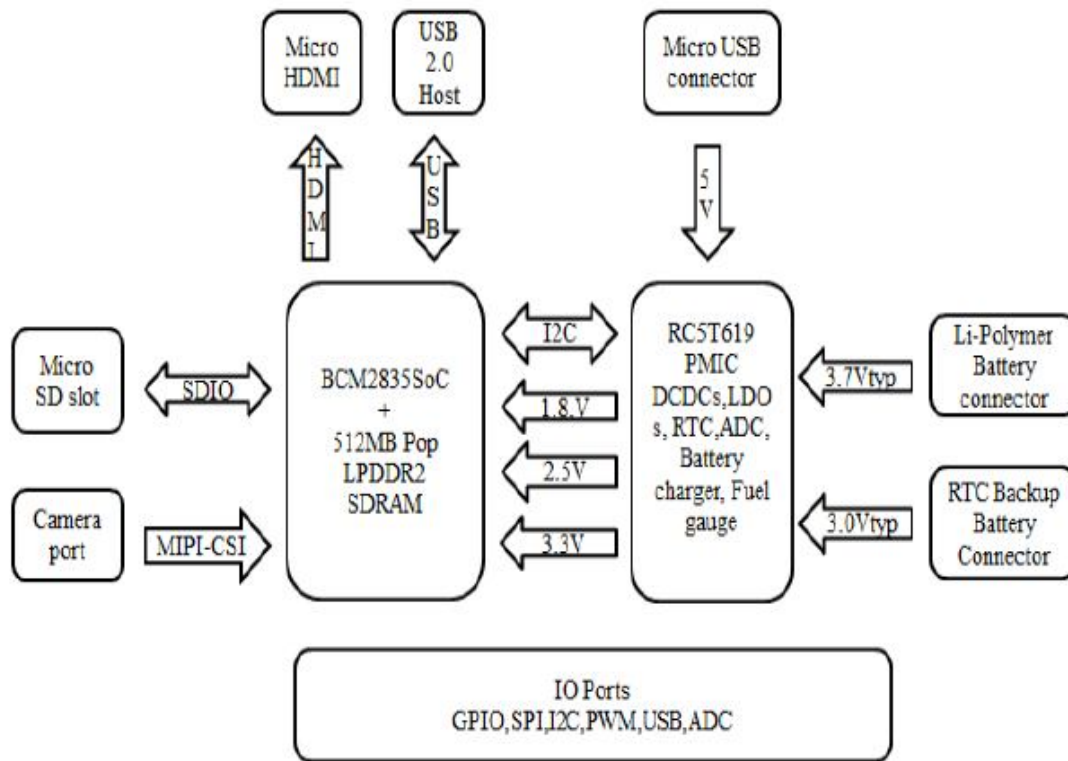
Block diagram of Raspberry Pi 3 model

The Raspberry pi does not feature with a built-in hard disk or solid-state drive like traditional computers instead it relies on the SD card for the starting up and storing of information. For the Raspberry Pi the SD card does the same job as a hard drive does in a traditional computer. The SD card must contain the operating system, programs and the data needed to run the Raspberry Pi. The operating system tells the Raspberry Pi how to function, how to handle any input from the user and how to manage programs when they are running
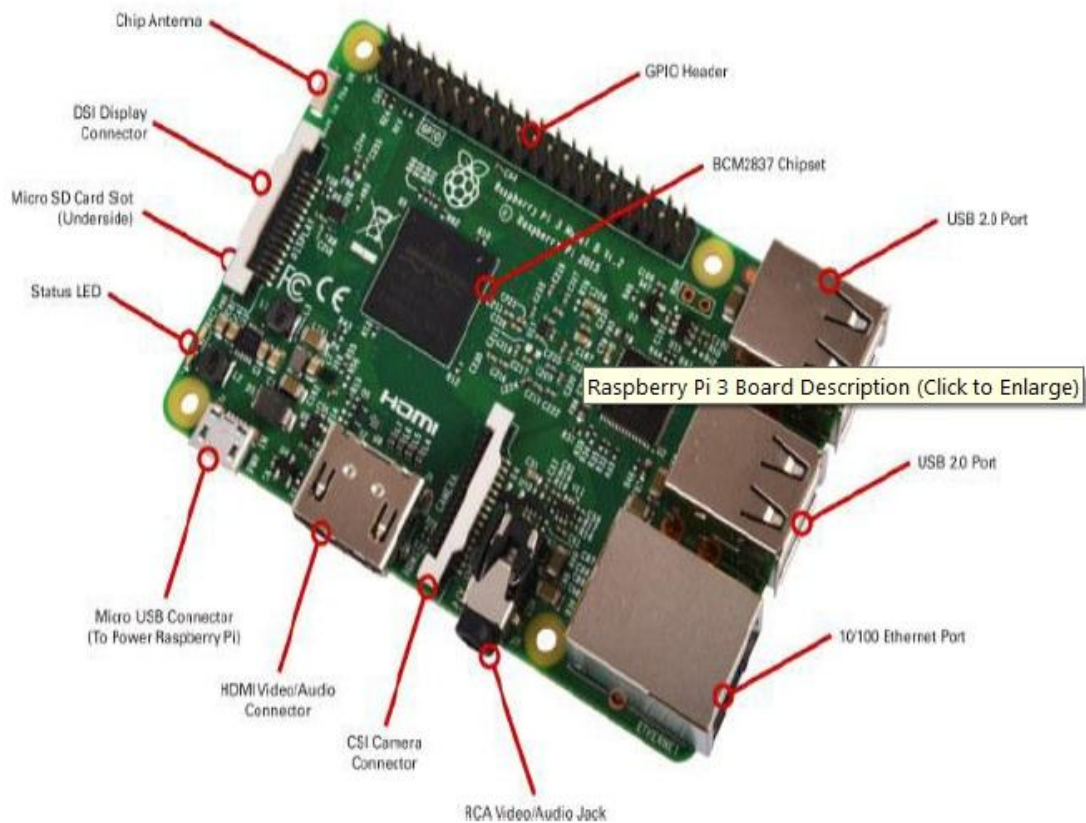
RASPBERRY PI 3 MODEL KIT
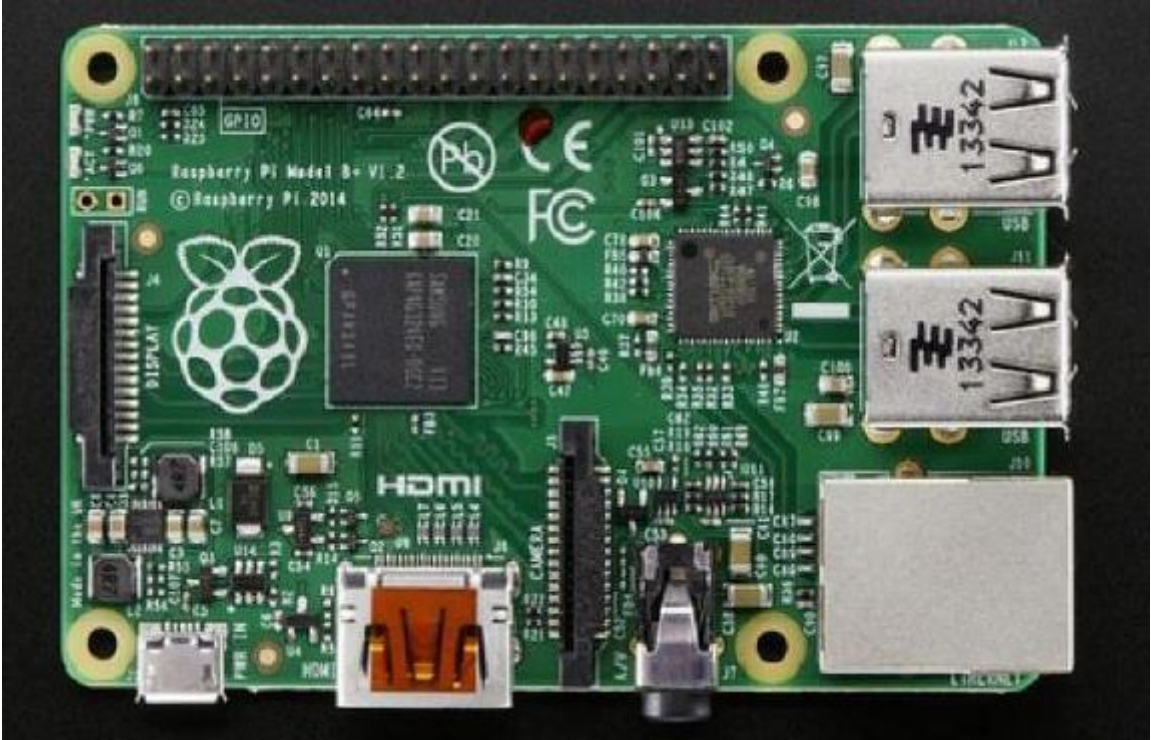
Raspberry Pi 3 model kit

RASPBERRY PI 3 MODEL KIT DESCRIPTION

Raspberry Pi 3 board was first found on the FCC website, and thanks to various other leaks we had a pretty good idea of the board specifications **17** including a Broadcom 64-bit ARM processor coupled with 1GB RAM, Wi-Fi and Bluetooth, as well as basically the same features and ports as Raspberry Pi 2 Model B. But with the fourth anniversary of the Raspberry Pi Model 1 board, Raspberry Pi 3 has now officially been launched, and you can now purchase the board for $35.

Raspberry Pi 3 Model Kit Description

RASPBERRY PI 3 MODEL SPECIFICATIONS

1. SoC – Broadcom BCM2837 64bit ARMv8 quad core Cortex A53 processor @ 1.2GHz with dual core Video Core IV GPU @ 400 MHz supporting OpenGL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode. Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure.

2. System Memory – 1GB LPDDR2.

3. Storage – micro SD slot.

4. Video & Audio Output – HDMI 1.4 and 4-pole stereo audio and composite video port.

5. Connectivity – 10/100M Ethernet, Wi-Fi 802.11 b/g/n up to 150Mbps and Bluetooth 4.1 LE (BCM43438 module).

6. USB – 4x USB 2.0 host ports (with better power management, allowing higher power peripherals), 1x micro USB port for power.

7. Expansion

    1. 40-pin GPIO header.

    2. MIPI DSI for Raspberry Pi touch screen display.

    3. MIPI CSI for Raspberry Pi camera.

8. Power Supply – 5V up to 2.4A via micro USB port.

9. Dimensions – 85 x 56 x 17 mm.

RASPBERRY PI 3 MODEL FEATURES

1. CPU‑700 MHz Low Power ARM1176JZ-F Applications Processor

2. GPU‑Dual Core Video Core IV Multimedia Co-Processor

3. Memory‑512MB SDRAM

4. Ethernet on board 10/100 Ethernet RJ45 jack

5. Four USB Connectors (USB 2.0).

6. Video Output- HDMI (rev 1.3 & 1.4) Composite RCA (PAL and NTSC)

7. Audio Output-3.5mm jack, HDMI

8. On board Storage- SD, MMC, SDIO card slot

## ADVANTAGES OF RASPBERRY PI

1. Raspberry Pi is as small as the size of a credit card, it works as if a normal Computer at a relatively low price.

2. It is possible to work as a low-cost server to handle light internal or web traffic.

3. Grouping a set of Raspberry Pi to work as a server is more cost-effective than a Normal server. If all light traffic servers are changed into Raspberry Pi, it can Certainly minimize an enterprise's budget.

APPLICATIONS

1. Home automation

2. Media streamer

3. Arcade machine

4. Tablet computer

5. Controlling robots

RASPBERRY PI 3 HARDWARE

The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.
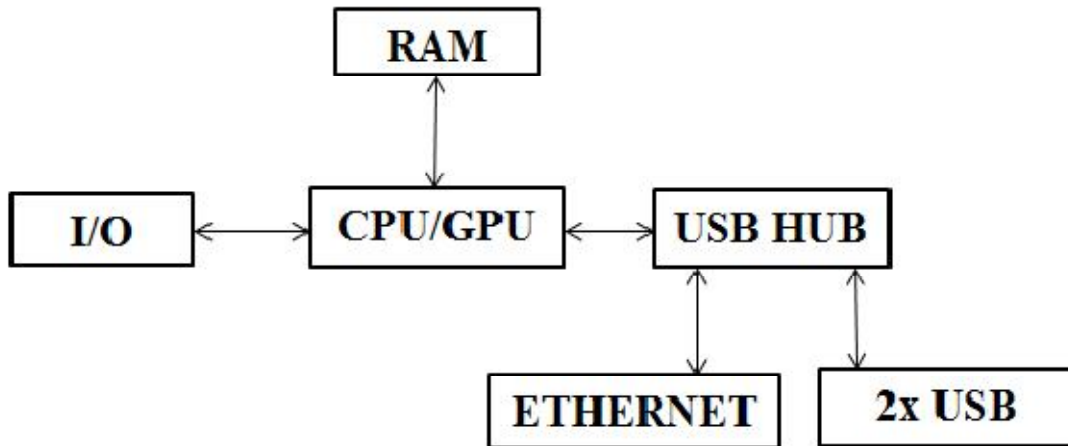
This block diagram depicts Models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the PI Zero, the USB port is connected directly to the system on a chip (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

BROADCOM BCM2837 CPU

ARM11 Cortex-53

The ARM11 cortex-53 processor incorporates an integer core that implements the ARM11 ARM architecture v6. It supports the ARM and Thumb™ instruction sets, Jazzle technology to enable direct execution of Java byte codes, and a range of SIMD DSP instructions that operate on 16-bit or 8-bit data values in 32-bit registers.

ARM11 Cortex-53 PROCESSOR FEATURES

1. High-speed Advanced Microprocessor Bus Architecture (AMBA)

2. Advanced Extensible Interface (AXI) level two interfaces supporting
Prioritized multiprocessor implementations.

3. An eight-stage pipeline.

4. ARMv6 Architecture.

5. Low interrupt latency configuration.

6. Internal coprocessors CP14 and CP15.

7. Vector Floating-Point (VFP) coprocessor support.

8. External coprocessor interface.

9. Instruction and Data Memory Management Units (MMUs)

10. Virtually indexed and physically addressed caches

11. 64-bit interface to both caches

12. Level one Tightly-Coupled Memory (TCM) that you can use as a
 local RAM with DMA.

13. JTAG-based debug.

It supports the ARM and Thumb™ instruction sets, Jazelle technology to enable direct execution of Java byte codes, and a range of SIMD DSP instructions that operate on 16-bit or 8-bit data values in 32-bit registers. It supports the ARM and Thumb™ instruction sets and is in the direct execution of the codes.

It has eight-stage pipeline, ARMv6 Architecture, Low interrupt latency configuration, Internal coprocessors CP14 and CP15, Vector Floating-Point (VFP) coprocessor support, External coprocessor interface.
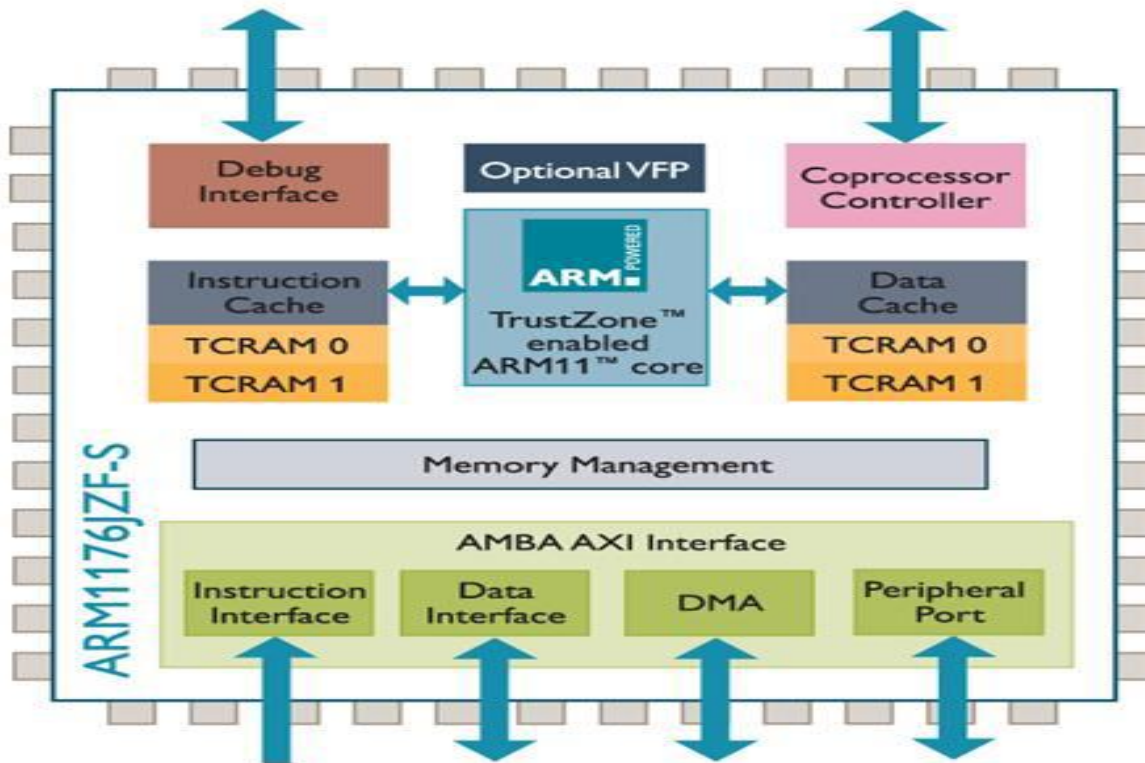
ARM11 Processor Block Diagram
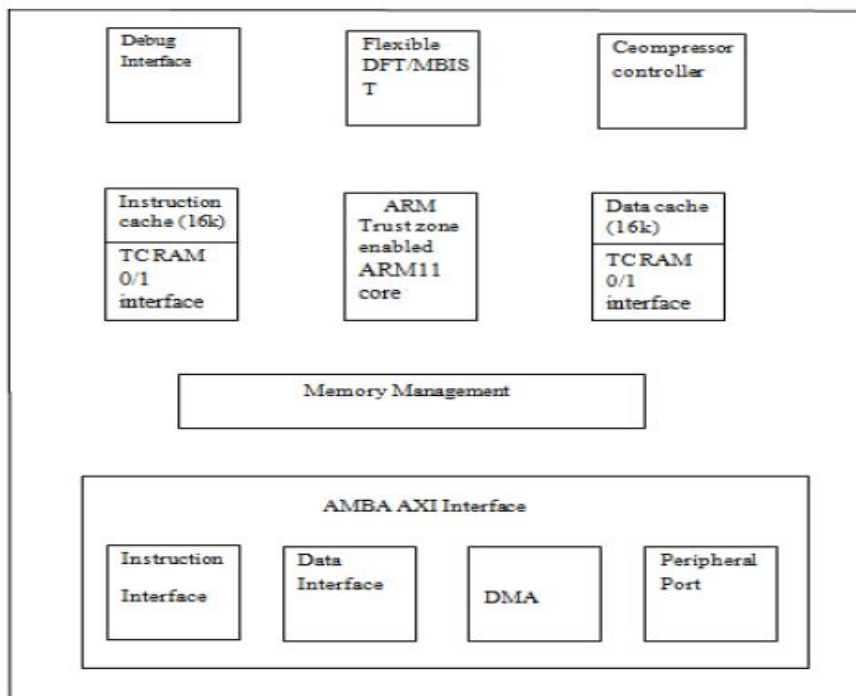
Architecture of ARM11

PORT DESCRIPTION

MEMORY CARD SLOT

As the RASPBERRY Pi has no internal mass storage or built-in operating System it requires an SD card preloaded with a version of the Linux Operating System using any suitable SD card (4GBytes or above).

USB CONNECTOR

There are four USB port available for raspberry pi b+ model. These USB ports Are used to interface keyboards, mouse and other peripherals which having USB connectivity. Wireless keyboard/mice should also function, and only Require a single USB port for an RF dongle

GPIO CONNECTOR

Raspberry Pi have 40 GPIO (General Purpose input output) with 2.54 mm(100 mil) expansion header. These pins are used for general input output control. Among those 40 GPIO pins 5 pins can use as ground and 2 pins can use For supply.

			P5: Secondary GPIO connector (Rev. 2 Pi only)				
WiringPi Pin	BCM GPIO	Name	Header		Name	BCM GPIO	WiringPi Pin
		5v	1	2	3.3v		
17	28	GPIO8	3	4	GPIO9	29	18
19	30	GPIO10	5	6	GPIO11	31	20
		0v	7	8	0v		
WiringPi Pin	BCM GPIO	Name	Header		Name	BCM GPIO	WiringPi Pin

Main GPIO Connector pin

GPIO connectors

POWER SUPPLY

Power Supply is the device that transfers electric power from a source to a load using electronic circuits. Power supplies are used in many industrial and aerospace applications and also in consumer products. Some of the requirements of power supplies are small size, lightweight, low cost, and high power conversion efficiency. The unit is powered via the micro-USB connector (only the power pins are connected, so it will not transfer data over this connection). A standard modern phone charger with a micro-USB connector will do, providing it can supply at least 700mA at +5Vdc.

Experiments

LED BLINKING

Aim :

Blinking LED using C program

Components Required :

Raspberry pi board , LED , 1 - 50 ohm resistor ,Some small-gauge solid core wire ,Breadboard and/or alligator clips to hold connections

Procedure :

- To install wiring Pi library
- Connect the LED & Resistor as shown in the Fig.1
- Write & execute the below code

Program :

```
#include <stdio.h>

#include <wiringPi.h>


// LED Pin - wiringPi pin 0 is BCM_GPIO 17.

#define LED     0

int main (void)

{

  printf ("Raspberry Pi blink\n") ;

  wiringPiSetup () ;

  pinMode (LED, OUTPUT) ;

for(;;)

{
```
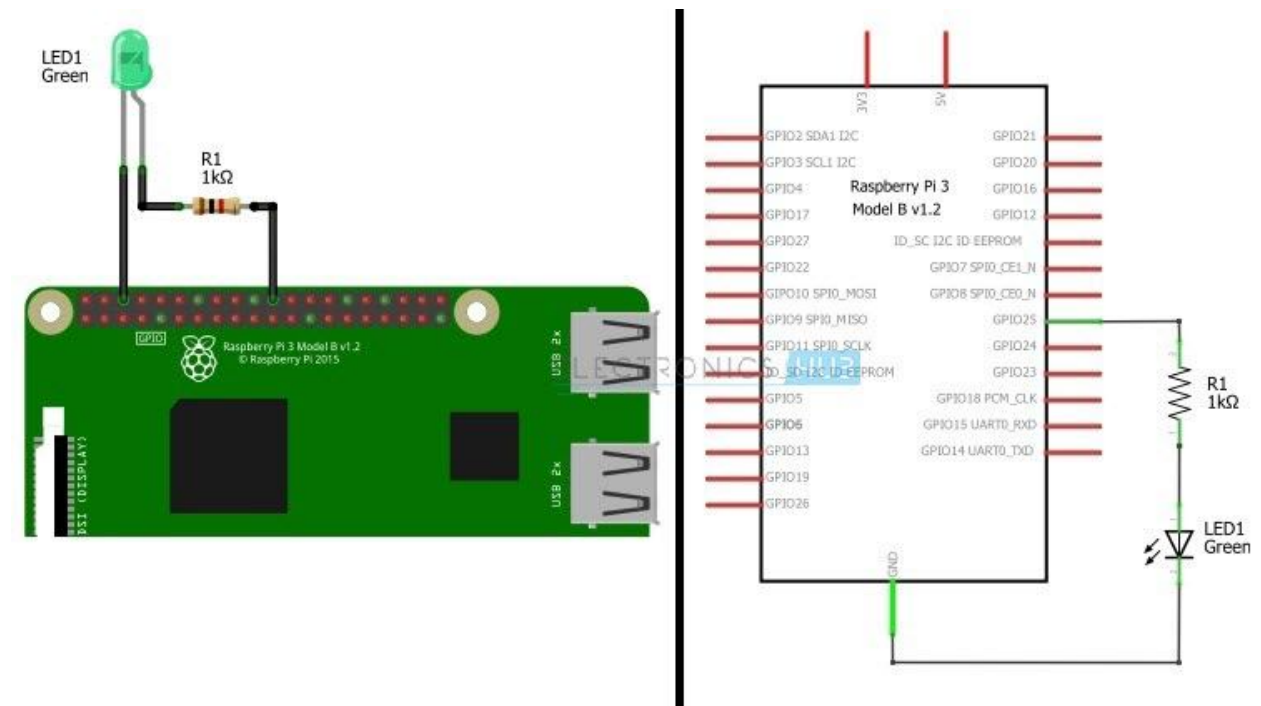
```
   digitalWrite (LED, LOW) ;   // On

  delay (500) ;                // mS

  digitalWrite (LED, LOW) ;    // Off

  delay (500) ;

}

 return 0 ;

}
```

Configuration :

Fig. 1

LED ON / OFF based on Input Switch Condition

Aim:

        Read the status of switch & Turn ON/OFF the LED based on the switch condition.

Requirements :

Raspberry pi ,jumper wires, bread board , switches , LEDs

Procedure :

- o Install the wiring Pi library
- o Make the switch & LED connection as shown the fig.2

Program :

#include <stdio.h>

#include <wiringPi.h>

// LED Pin - wiringPi pin 0 is BCM_GPIO 17.

// switch BCM_GPIO 22

#define LED   0

#define SWITCH 3

int main (void)

{

 printf ("Raspberry Pi Switch\n") ;

 wiringPiSetup () ;

 pinMode (LED, OUTPUT) ;

 pinMode (SWITCH, INPUT);

for(;;)

{

```
if (digitalRead(SWITCH)==1)

{

   digitalWrite (LED, HIGH) ;   // On

}

else

   digitalWrite (LED, LOW) ;    // Off

}

   return 0 ;

}
```
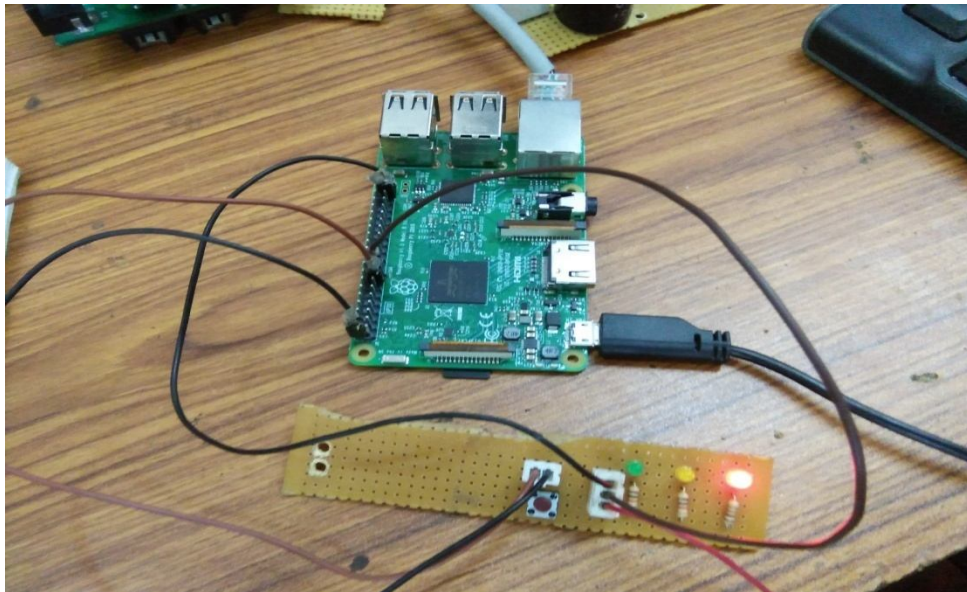
Sample

Fig. 2

OBJECT DETECTION BASED ON IR SENSOR

Aim :

Write the C Program to detect the object using IR sensor.

Procedure :

- Install wiring Pi Library
- The circuit connection must be like as fig. 3
- If the object found the output would be true else false.

Program :

#include <stdio.h>

#include <wiringPi.h>

// LED Pin - wiringPi pin 0 is BCM_GPIO 17.

// switch BCM_GPIO 22

#define LED   0

#define IR 3

int main (void)

{

  printf ("Raspberry Pi Switch\n") ;

  wiringPiSetup () ;

  pinMode (LED, OUTPUT) ;

  pinMode (IR, INPUT);

for(;;)

{

if (digitalRead(IR)==1)

```
{

    digitalWrite (LED, HIGH) ;   // On

    printf("object detect");


}

else

  digitalWrite (LED, LOW) ;    // Off

  printf("No object detect");

}

  return 0 ;

}
```
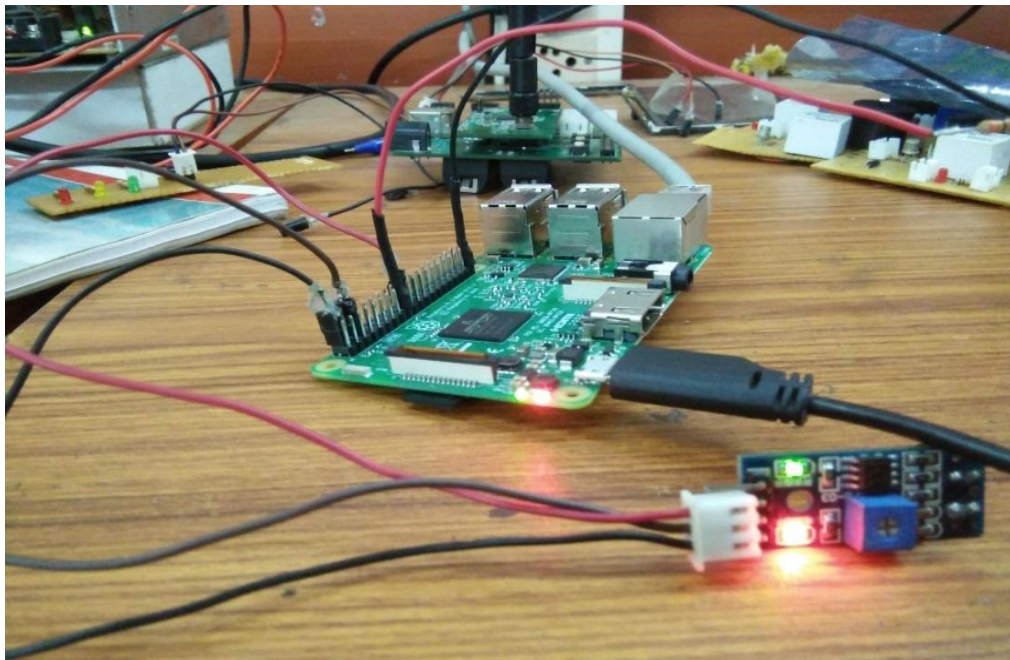
Sample

Fig.3

Flame sensor

Aim :

To detect the flame using flame sensor in C program

Procedure:

- If the flame is detected by sensor it will change its state to true
- That state will read indefinitely so whenever the state will change
- It will trigger ,turn on LED
- Otherwise nothing will happen

Program :

```
#include <stdio.h>

#include <wiringPi.h>

// LED Pin - wiringPi pin 0 is BCM_GPIO 17.

// switch BCM_GPIO 22

#define LED     0

#define FLAME  3

int main (void)

{

 printf ("Raspberry Pi Switch\n") ;

 wiringPiSetup () ;

 pinMode (LED, OUTPUT) ;

 pinMode (FLAME, INPUT);

for(;;)

{

if (digitalRead(FLAME)==1)
```

```
{

    digitalWrite (LED, HIGH) ;   // On

    printf("flame detect");

}

else

{

    digitalWrite (LED, LOW) ;    // Off

    printf("No flame detect");

}

    return 0 ;

}
```
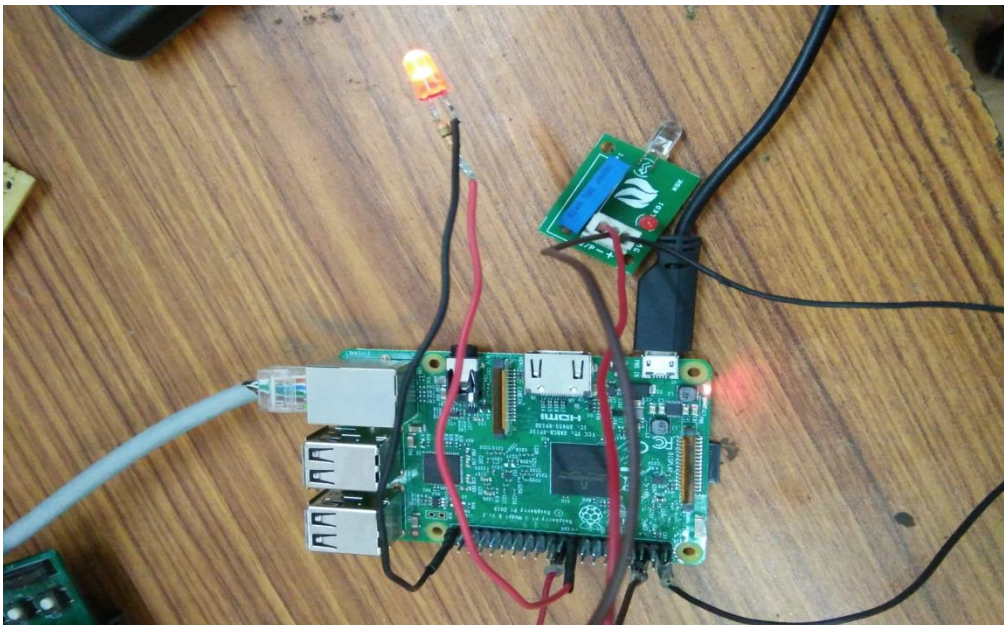
Sample

Fig.4

Relay based LED Control

Aim :

To turn on the Led based on relay output

Procedure :

- If the motion is detected by sensor it will change its state to true
- That state will read indefinitely so whenever the state will change
- It will trigger ,turn on LED
- Otherwise nothing will happen

Program :

```
#include <stdio.h>

#include <wiringPi.h>


// RELAY- wiringPi pin 0 is BCM_GPIO 17.

// switch BCM_GPIO 22

#define RELAY  0

#define SENSOR  3

int main (void)

{

 printf ("Raspberry Pi Relay \n") ;

 wiringPiSetup () ;

 pinMode (RELAY, OUTPUT);

 pinMode (SENSOR, INPUT);
```
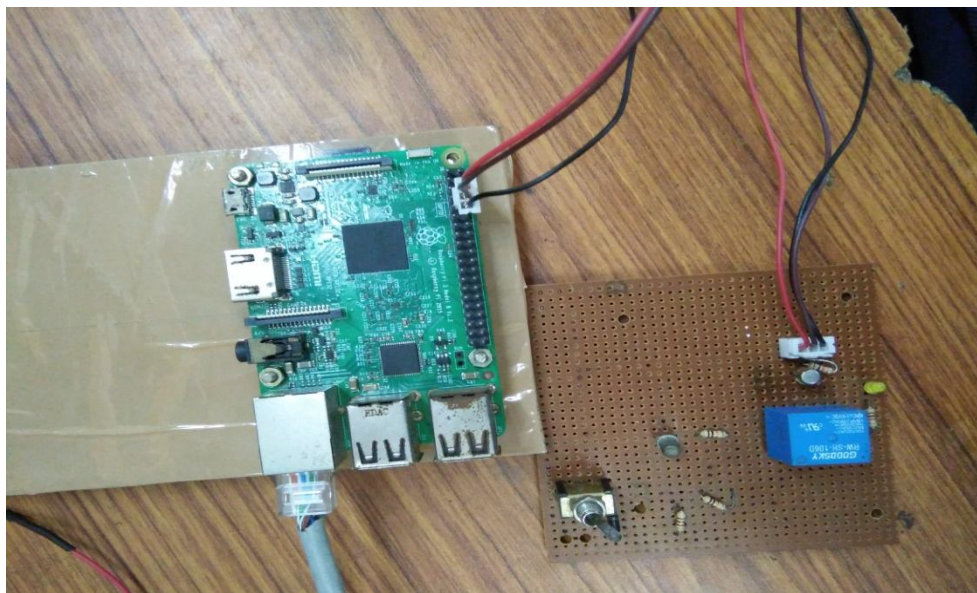
```
for(;;)

{

if (digitalRead(SENSOR)==1)

{

    digitalWrite (RELAY, HIGH) ;   // On


}

else

    digitalWrite (RELAY, LOW) ;    // Off

}

  return 0 ;

}
```

SAMPLE

Fig.5

Web Based LED Control

Aim :

      To control LED based on WEB UI

Procedure :

- Here we give two pics ON and OFF LED
- IF I click the On Pic ,it will run the Script for on the LED(java script client side and cgi script on server side)
- And Like similar to Off the LED

Program :

//index.html

```html
<html>
<head>
<script Language="Javascript">
function set0()
{
  document.location="cgi-bin/straight.cgi";
}
function set1()
{
  document.location="cgi-bin/right.cgi";
}
</script>
</head>
```
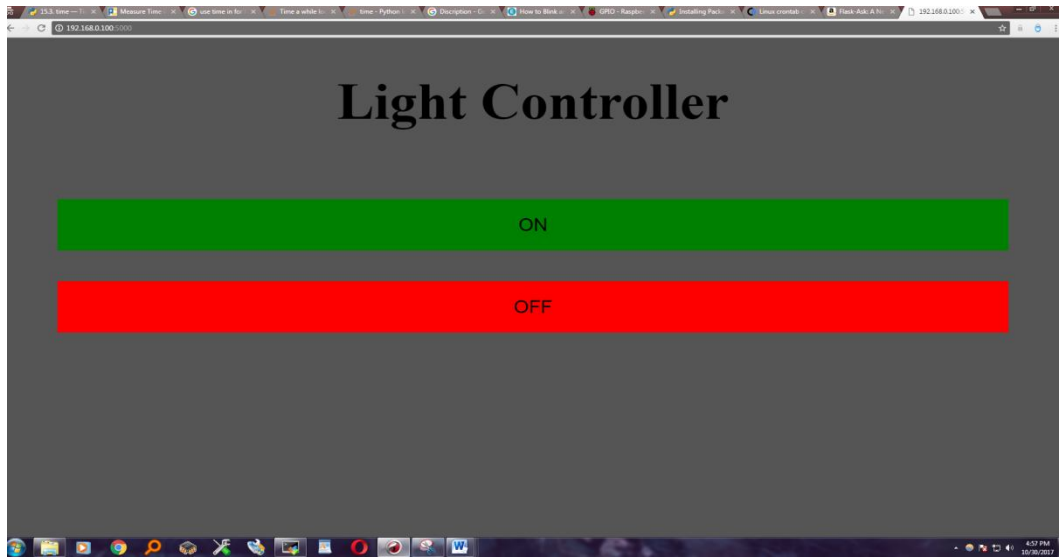
```
<body bgcolor="#9370DB">
 <div style="text-align:center">
  <h1>Led control ON/OFF</h1>
  <br>
  <img src="on.jpg" id="l" onmousedown="set0()" style="width:204px;height:228px">
  <img src="off.jpg" id="r" onmousedown="set1()" style="width:204px;height:228px">
 <br>
 </div>
 </body>
</html>
//on.cgi
#!/bin/bash
gpio -g mode 17 out
gpio -g write 17 1
echo "Status: 204 No Content"
echo "Content-type: text/html"
echo ""
echo "<h1>Motor OFF</h1>"
//off.cgi
#!/bin/bash
gpio -g mode 17 out
gpio -g write 17 0
echo "Status: 204 No Content"
echo "Content-type: text/html"
echo ""
echo "<h1>Motor OFF</h1>"
```

Vi Microsystems Pvt. Ltd., established in 1986, with a prime motto to "Design and Develop the Hardware and Software products" is headed by an educationalist and Ex-Scientist from Government of India, with the enormous experience gained in Research & Development. This organization had established to keep in tune with the developing technologies in the field of Electrical, Electronics, Instrumentation, Mechanical, Chemical etc.,

The Company has its own massive three-stroke building with a built in area of about 18,000 square feet in Chennai. The company has a effective work force of about 200 people working in various departments such as Sales, Service, R&D, Production, Quality Control, Finance, Purchase, Project etc. Each department has well stuffed Engineers and highly qualified Professionals working to achieve the objectives of the organization. The company has its own R&D wing recognized by Department of Scientific & Industrial Research, Government of India. By increasing its operations multifold the company could provide employment to more people in its various different departments.

To start with, the company was engaged in the manufacture of Microprocessor Trainers and Interface Boards. With the efforts from our Research and Development Team, the company has expanded its activities in various areas as follows. Microcontroller, Process Control Instrumentation, Digital Signal Processing, Power Electronics & Drives, Data Acquisition Systems, Personal Computer Trainer Systems, VLSI & Embedded Systems etc. Now our annual turnover is around Rs.30 Crores.

At present, the company is concentrating in various new fields like Advanced Control Systems, Solar Heat Pump Trainers, Advanced Process control, Chemical Reactors, Distillation Column, Image Processing, Nuclear Electronics, Defence projects etc.,

The Company also offer good sales support with effective service backup and technical support team. The company has built up a high degree of reputation and credibility by its dedicated after sales service support. The company also few export orders in Singapore, Malaysia, Tunisia, Ethiopia, Ghana etc.,

It is also engaged in distributing some of the good products manufactured by other manufacturers. The company is also distributing Software's like OrCAD, Nucleolus RTOS, Ride 'C' IAR Workbenches, MiPower, VisSim, PLC SCADA etc…

Total Customer Satisfaction

Vi Microsystems Pvt. Ltd.,

ENGINE   VLSI   EMBEDDED   POWER ELECTRONICS   MECHATRONICS   PLC   Process control   COMMUNICATION

Vi Microsystems Pvt.Ltd.,