American International University- Bangladesh
Department of Electrical and Electronic Engineering
EEE4103: Microprocessor and Embedded Systems Laboratory

Title: Familiarization with Raspberry Pi

Introduction:

The objective of this experiment is to get familiarized with Raspberry Pi.

Theory and Methodology:

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The most important thing about different versions of Raspberry Pi is that, it is a computer that costs $5 to $75.

Hardware

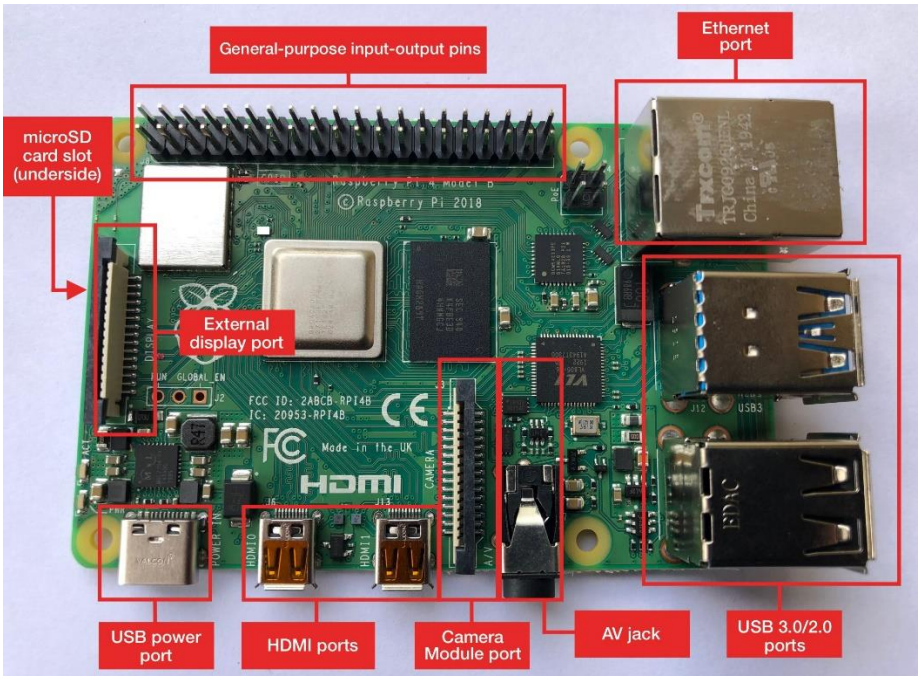

Figure 1: Raspberry Pi 3 - Model B

In this laboratory version, **Raspberry Pi 3 - Model B** will be used. Thus, only hardware specification of Raspberry Pi 3 – Model B is discussed.

Technical Specification

1. Processor

- Broadcom BCM2387 chipset.
- 64-bit 1.2GHz Quad-Core ARM Cortex-A53.

2. 802.11 b/g/n Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)

- IEEE 802.11 b / g / n Wi-Fi. Protocol: WEP, WPA WPA2, algorithms AES-CCMP (maximum key length of 256 bits), the maximum range of 100 meters.
- IEEE 802.15 Bluetooth, symmetric encryption algorithm Advanced Encryption Standard (AES)with 128-bit key, the maximum range of 50 meters.

3. GPU

- Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GL ES 2.0, hardwareaccelerated Open VG, and 1080p30 H.264 high-profile decode.
- Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure.

4. Memory

- 1GB LPDDR2.

5. Operating System

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

6. Dimensions

- 85 x 56 x 17mm

7. Power

- Micro USB socket 5V1, 2.5A

8. Ethernet

- 10/100 Base T Ethernet socket.

9. Video Output

- HDMI (rev 1.3 & 1.4)
- Composite RCA (PAL and NTSC)

10. Audio Output

- Audio Output 3.5mm jack
- HDMI
- USB 4 x USB 2.0 Connector

11. 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

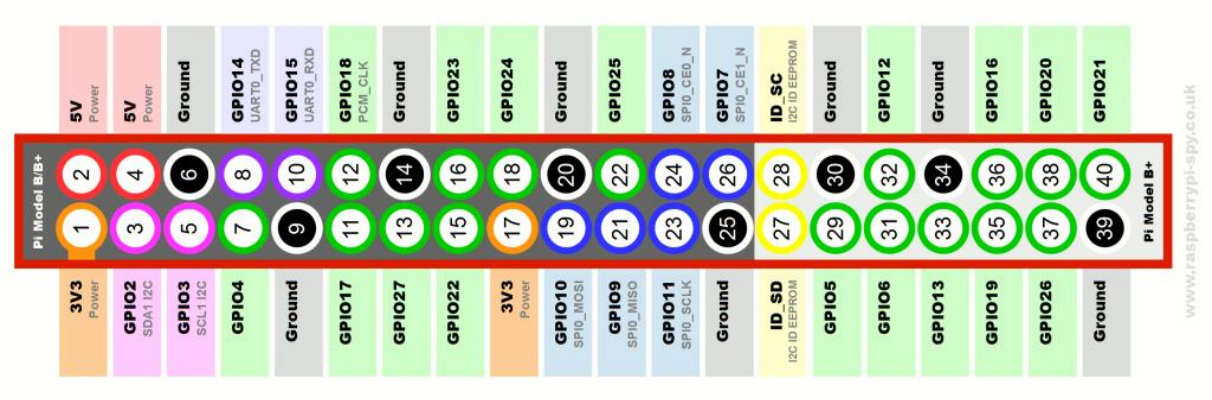

Figure 2: Raspberry Pi 3 - Model B GPIO pin

12. Camera Connector

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

13. Display Connector

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

14. USB

- Four built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the RPi needs.

15. Antenna

- There's no need to connect an external antenna to the Raspberry Pi 3. Its radios are connected to this chip antenna soldered directly to the board

16. HDMI connector:

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

17. Status LED

There are five status LEDs on the corner of the board.

ACT	Green	Lights when the SD card is accessed/used
PWR	Red	steady ON when Pi is connected to 3.3V power

FDX	Green	On if network adapter is full duplex
LNK	Green	Network activity light On when Ethernet is connected
100	Yellow	On if the network connection is 100Mbps

The status LEDs give information about the operating condition and any problems of the board e.g.

Status LED	Possible Problem
Red power LED does not light, nothing on display	The power is not properly connected
The LED light is blinking	The red power LED should never blink. Blinking RED LED (PWR) means the 5V power supply is dropping out. Use a different power supply.
Red power LED is on, green LED is glowing faintly and steadily	Power supply is OK. But faint and steady green light (ACT) means SD card has some problem in starting the operating system (no boot code).

Setting Up the Raspberry Pi:

What You Will Need?

1. Raspberry Pi
2. Monitor
3. Display and Connectivity Cable (HDMI/DVI)
4. Keyboard and Mouse
5. Power Supply (good-quality power supply that can supply at least 2A at 5V for the Model 3B)
6. SD Card (minimum 4 GB)
7. Ethernet (network) cable (Optional)
8. Audio Lead (Without an HDMI Cable an audio lead is necessary to produce sound)

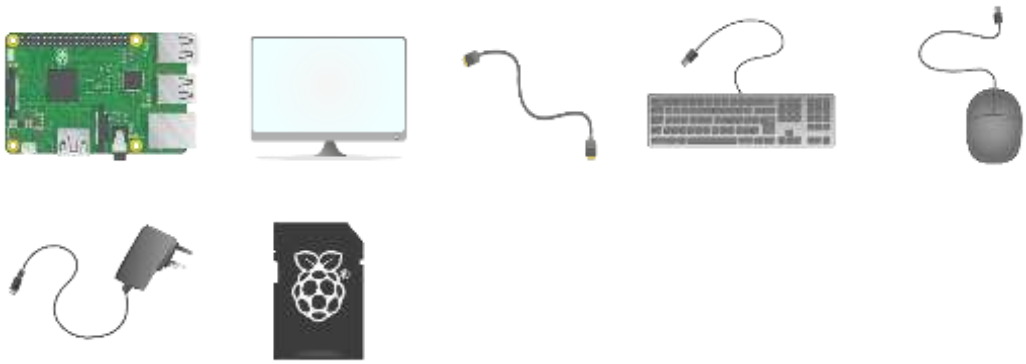

Figure 3: Apparatus for Setting Up Raspberry Pi

Operating Systems

When setting up Raspberry Pi, always keep in mind that you are actually setting up a small PC. Like a PC set up Pi must be set up with Operating System (OS). **Raspbian** is the official operating system for all models of the Raspberry Pi. However, there are third party operating systems like Ubuntu Mate, Snappy Ubuntu Core, Windows 10 IOT core, OSMC, Libreelec, Pinet and RISC OS. Logos of different OS for Pi is shown in following Fig. 7.

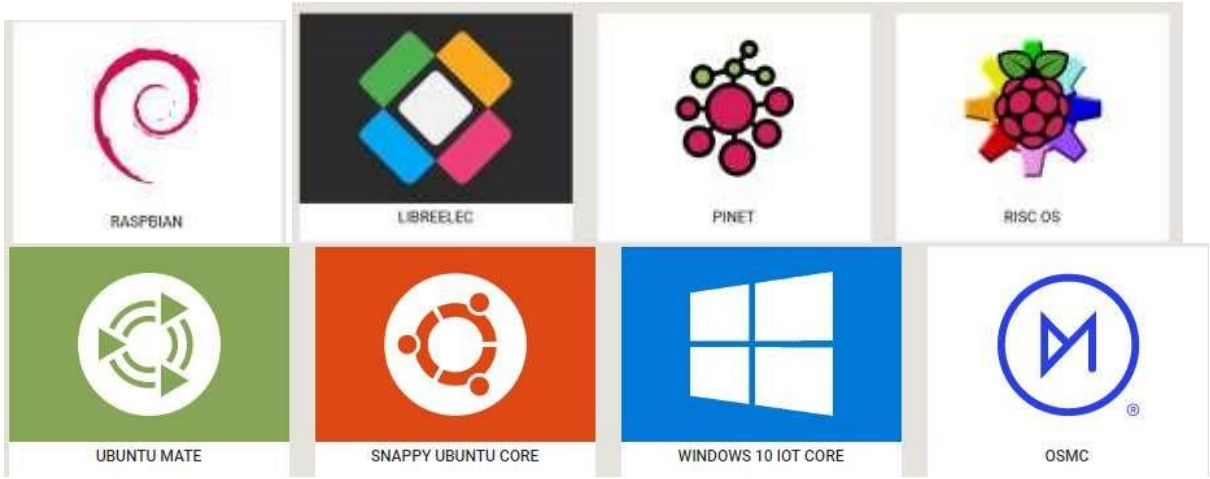

Figure 4: Logos of Different Operating Systems

Getting an operating system

The recommended operating system for use with the Raspberry Pi is called Raspbian. Raspbian is a version of GNU/Linux, designed specifically to work well with the Raspberry Pi.

Download and image Raspbian directly: This is a faster process and is great if you need to image multiple cards for a workshop or class. The steps are given below:

I. Using a computer with an SD card reader, visit the official Raspberry Pi Downloads page. Link: https://www.raspberrypi.org/downloads/
II. Go to the following link to know the step-by-step process to install the Raspberry Pi imager first: https://www.youtube.com/watch?v=ntaXWS8Lk34
III. The following link will help to know step by step process to configure the Raspberry Pi: https://www.youtube.com/watch?v=wjWZhV1v3Pk
IV. The following link will help to know step by step process to update the Raspberry Pi: https://www.youtube.com/watch?v=y9KlLxtMTOA

Power on your Raspberry Pi for the first time

Remember that after booting the Pi, the user credentials like the "username" and password will be asked. Raspberry Pi comes with a default user name and password and so always use it whenever it is being asked. The credentials are:

```
login: pi

password: raspberry
```

LAB Exercise: Simply Glowing an LED

Introduction: In this experiment an LED will be controlled by using Raspberry Pi. Python will be used to blinking an LED. This experiment will give a basic idea of Python language as well as importing GPIO pins of Raspberry Pi. This experiment will be done from Linux environment thus enable to use of terminal and shell scripting. As Raspberry Pi runs on Linux environment it is always advised to use text editors like Gvim, Nano editor, Emacs Editor and Pico Editor. However, when you installed your Raspbian it comes with Integrated development environment for Python.

Apparatus:

1) Activated Raspberry pi
2) LED
3) Resistor (220□)
4) Breadboard
5) Jumper wires

Experimental Procedure:

1) The first step of this lab task is to setup the circuit as shown in Fig13.

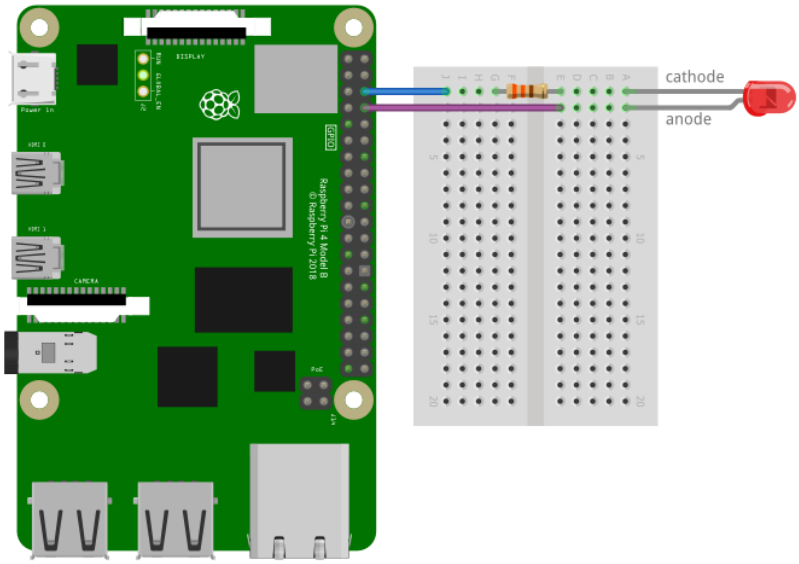

Figure 5: Setting Up Circuit

2) After setting up the circuit Raspberry Pi should be powered On interfaced with Monitor and Key Board.
3) Open the terminal.
4) Write your code according to the following code example in the terminal.

```
nano blinkLED.py              #to create a text file under the name blinkLED

import RPi.GPIO as GPIO       # RPi.GPIO library will allow us to control the GPIO pins.
import time                     # time library contains the sleep()

GPIO.setmode(GPIO.BCM)        #BCM pin numbering is used
GPIO.setwarnings(False)        #to disable warnings
GPIO.setup(14,GPIO.OUT)       # to set GPIO14 as an output

GPIO.output(14,GPIO.HIGH)       # to specify the GPIO 14 as high
print "LED is ON"                 # show message to Terminal
time.sleep(1)                      # for one second

GPIO.output(14,GPIO.LOW)         # to specify the GPIO 14 as low
print "LED is OFF"                # show message to Terminal
```

To save the program, press in "Ctrl+x" then "y" then "enter".
To simply run the program type :

```
sudo python blinkLED.py
```

The LED will turn on for a second and then turn off.

Lab Task: Design a traffic control system using RED, YELLOW, and GREEN LEDs.

Questions for report writing:

1) Include all codes and scripts in the lab report
2) Include simulation in proteus simulation tool after learning from: https://www.youtube.com/watch?v=GIP7a_y0zCo

Reference(s):

1) Raspberry pi datasheet.