Edge Computing Lab

Class: TY-AIEC

School of Computing, MIT Art Design Technology University

Academic Year: 2024-25

Experiment No. 1

Title: "Hello World" to Raspberry Pi

Raspbian OS Installation and Configuration on Raspberry Pi 4 and familiar with Raspberry Pi 4 GPIO's

Introduction

This manual provides a comprehensive guide for undergraduate students to understand the OS installation process using the Raspbian OS Imager, and configure remote access tools like PuTTY and VNC Viewer on Raspberry Pi 4.

Prerequisites

- Raspberry Pi 4
- MicroSD card (minimum 8 GB)
- Raspbian OS Imager software
- PuTTY for SSH access
- VNC Viewer for remote desktop access
- Internet connection
- Additional peripherals (monitor, keyboard, mouse, etc.)

Experiment Steps

Part 1: Installing Raspbian OS

Detailed steps on using the Raspbian OS Imager to select the correct version of the OS and write it to the MicroSD card. Illustrations will include screenshots of the imager interface and selection process.

Part 2: Setting Up Raspberry Pi

Instructions on inserting the MicroSD card into the Raspberry Pi, connecting all necessary peripherals, and completing the initial boot process. This section will include diagrams showing how to connect the Raspberry Pi to various peripherals.

Part 3: Configuring PuTTY for SSH Access

Step-by-step guide on installing PuTTY, finding the Raspberry Pi's IP address, and establishing an SSH connection. This section will contain figures illustrating the PuTTY configuration settings.

Part 4: Setting Up VNC Viewer

Detailed instructions on enabling VNC on the Raspberry Pi through the terminal or Raspberry Pi configuration settings, and connecting via VNC Viewer. Screenshots will guide the user through the VNC setup and connection process.

Part 5: Interface the LED with Raspberry Pi 4 on GPIO14 using BCM

Experiments tis section designed to introduce students to the fundamentals of hardware interfacing using the Raspberry Pi 4. By the end of this lab, students will learn how to control an external LED using the GPIO pins of the Raspberry Pi.

Theory

GPIO (General Purpose Input/Output) pins on the Raspberry Pi are used for interfacing with other electronic components. BCM numbering refers to the pin numbers in the Broadcom SOC channel, which is a more consistent way to refer to the GPIO pins across different versions of the Raspberry Pi.

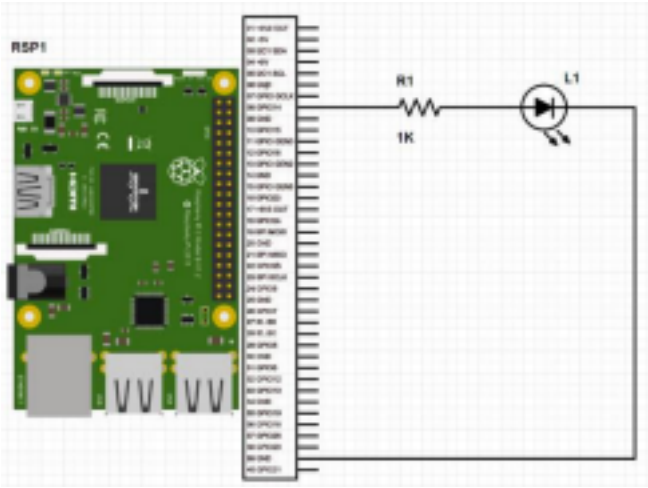
Things to Write:

1) Draw an interfacing diagram between LED and Raspberry Pi

2) Attach the copy of python code.

Circuit Diagram

An illustrative diagram showing how to connect the LED to the Raspberry Pi GPIO14 pin through a resistor using a breadboard will be included here.



Experiment Procedure

Detailed steps for setting up the Raspberry Pi, connecting the LED to the GPIO14 pin through the resistor, and securing all connections on the breadboard.

Python Code

A simple Python script to control the LED by turning it on and off will be provided, demonstrating the use of GPIO library and BCM pin numbering.

```python
import RPi.GPIO as GPIO
import time

# Use BCM GPIO references instead of physical pin numbers
GPIO.setmode(GPIO.BCM)

# Define GPIO signal to use (Physical pin 7 corresponds to BCM GPIO 4)
GPIO_LED = 4

# Set up the GPIO channel as output
GPIO.setup(GPIO_LED, GPIO.OUT)

try:
    # Loop to blink the LED on and off
    while True:
        # Turn LED on
        GPIO.output(GPIO_LED, True)
        print("LED ON")
        time.sleep(1)  # Sleep for 1 second

        # Turn LED off
        GPIO.output(GPIO_LED, False)
        print("LED OFF")
        time.sleep(1)  # Sleep for 1 second

except KeyboardInterrupt:
    # Clean up on Ctrl+C exit
    GPIO.cleanup()
```

Verification and Testing

Steps to verify the successful installation of the Raspbian OS, and the functionality of SSH and VNC connections, including sample commands and expected outputs.

Troubleshooting Tips

Common issues and their solutions related to OS installation, SSH, and VNC connections, supported by troubleshooting flowcharts and diagrams.

Observation

Students are expected to observe the LED turning on and off in response to the Python script, demonstrating the successful interfacing and control of external hardware with the Raspberry Pi

Conclusion

A summary of the key learning points from the manual and encouragement for students to explore further applications and configurations of the Raspberry Pi 4.

Things to write:

Q2] Describe the step-by-step process of installing an OS on Raspberry Pi using Raspberry Pi Imager.

Ans i] Download RaspberryPi Imager from RaspberryPi's official site.

ii] Insert microSD card into computer using card reader.

iii] Open Raspberry Pi Imager and choose OS.

iv] Select an OS.

v] Click Choose storage and select microSD card.

vi] Click write to start flashing the OS.

vii] Wait for completion and safely eject microSD card.

viii] Insert microSD card into Raspberry Pi and power it on.

Q3] How can PuTTY be used to establish an SSH connection with Raspberry Pi? What are the default login credentials?

Ans i] Enable SSH:

- If OS is already setup, enable SSH via sudo raspi-config.
- If setting up headless, create an empty file named ssh in the /boot partition of the microSD card.

ii] Find Raspberry Pi's IP Address.

iii] Download and open PuTTY on computer.

iv] Enter IP address of Raspberry Pi in PuTTY

v] Set the port to 22

vi] Click open to start SSH session.

vii] Login with default credentials.

Username : Pi

Password : raspberry.

Q4] Explain the purpose of VNC in Raspberry Pi. How can you enable and access the Raspberry Pi using VNC?

Ans:] Allows remote desktop access to Raspberry Pi's GUI.

ii] Useful when no monitor is connected.

iii] Supports file transfer and remote control.

Steps:

i] Enable VNC:

- Open terminal and run sudo raspi-config.
- navigate to interfacing options > VNC > enable.

ii] Install VNC viewer on your computer from RealVNC.

iii] Find Raspberry Pi's IP address.

iv] Open VNC viewer and enter the Raspberry Pi's IP.

v] Log in using default credentials.

vi] You now have remote GUI access to Raspberry Pi.

Q5] What are the advantages of using headless mode for Raspberry Pi, and how to configure?

Ans:] No need for a monitor, keyboard or mouse.

ii] Saves space and power.

iii] Remote access via SSH or VNC.

iv] Ideal for IoT projects and servers.

Configuration:

i) Flash Raspberry Pi using Raspberry Pi Imager.

ii) Enable SSH and WiFi before first boot:

- Create empty SSH file in /boot partition.
- Create a wpa_supplicant.conf file in /boot with wifi credentials:

```
country = IN
ctrl_interface = DIR=/var/run/wpa_supplicant
                 GROUP=netdev
network = {
    ssid = "Your_WiFi_SSID"
    psk = "Your_WiFi_Password"
    key_mgmt = WPA-PSK
}
```

iii) Insert the microSD card into the Raspberry Pi and power it on.

iv) Find the Raspberry Pi's IP address.

v) Connect via SSH (PuTTY) or VNC.

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Experiment No.1 : Introduction to Raspberry Pi, OS Installation, PuTTY, and VNC.

Questions :

Q.1] What are the key hardware components of a Raspberry Pi, and how does it differ from a traditional computer?

Ans i] System On Chip (SoC) : Integrates CPU, GPU & RAM
ii] RAM : Varies by Model (ex : 2GB, 4GB, 8GB).
iii] Storage : Uses Micro SD instead of internal HDD/SSD.
iv] GPIO pins : Allow direct hardware interfacing, unlike traditional PCs.
v] USB ports & HDMI Output : For peripherals & display.
vi] Ethernet and Wifi : For networking.
vii] Power supply : Uses a USB-C or micro USB adaptor.

Differences :
i] Compact and power efficient.
ii] No built-in storage (required microSD).
iii] Limited processing power, optimized for lightweight tasks.
iv] Focused on DIY projects, IoT, and embedded applications.