San Francisco Bay University

CE450 Fundamentals of Embedded Engineering
Lab 2 LED Driving

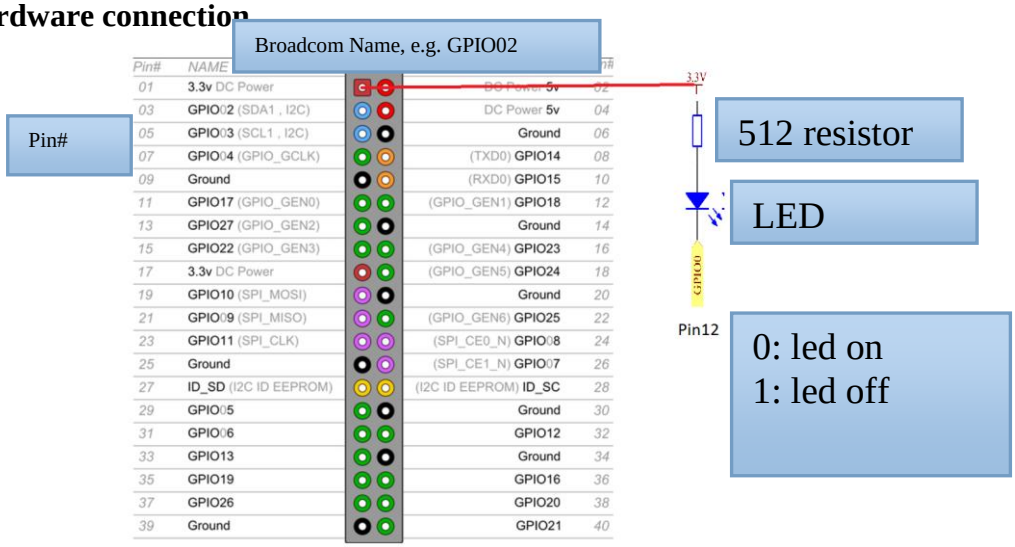
Equipment:

The equipment I am using is as follows:

- Laptop & Raspberry Pi 4B model Board
- FreeMove Starter Kit for Raspberry Pi

The Laboratory Procedure:

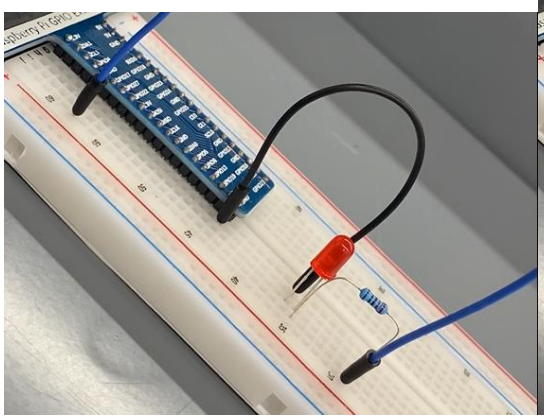
1. **Hardware connection**

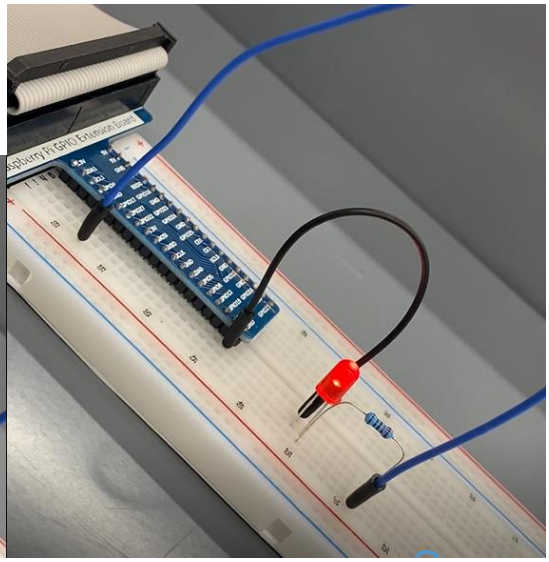


2. **Control program in Python**

```
import RPi.GPIO as GPIO          # RPi.GPIO – func. Lib for gpio port ctrl
import time

LedPin = 12                      # pin#

def setup():                     # port configuration
        global   p               # global var. p
        GPIO.setmode(GPIO.BOARD)        # Numbers GPIOs by physical location
        GPIO.setup(LedPin, GPIO.OUT)    # Set LedPin's mode is output
        GPIO.output(LedPin, GPIO.LOW)   # Set LedPin to low(0V) to switch on LED

        p = GPIO.PWM(LedPin, 1000)      # set Frequece to 1KHz
                                        # PWM: pulse width modulation

        p.start(0)                      # Duty Cycle = 0%; DC(Length of Voltage Hi)
```

```
                                                # p.start(20)=20% #0 means half-half
                                                # c.d = 0%,   0% 3.3v at pin 12
                                                # c.d = 50%, 50% 3.3v at pin 12
                                                # c.d = 20%, 20% 3.3v at pin 12

        def loop():
                while True: # In GPIO ctrl, must have a forever loop
                        for dc in range(0, 101, 4):   # Increase duty cycle: 0~100 step=4
                                p.ChangeDutyCycle(dc)       # Change duty cycle
                                time.sleep(0.05)            # time.sleep(sec)
                                                            # 1st iteration - dc=0:
holding 0% 3.3v at pin12 for 0.05 sec, led 100% on
                                                            # 2nd iteration - dc=4,
4% 3.3v, led 96% on
                                                            #100th iteration - dc =
100, 100% 3.3v, led 100% off
                        time.sleep(1)
                        for dc in range(100, -1, -4):       # Decrease duty cycle: 100~0
                                p.ChangeDutyCycle(dc)
                                time.sleep(0.05)
                        time.sleep(1)

        def destroy():
                p.stop()
                GPIO.output(LedPin, GPIO.HIGH)    # turn off all leds
                GPIO.cleanup()

        setup()
        try:
                loop()
        except  KeyboardInterrupt: # When 'Ctrl+C' is pressed, the child program destroy() will be  executed.
                destroy()
```





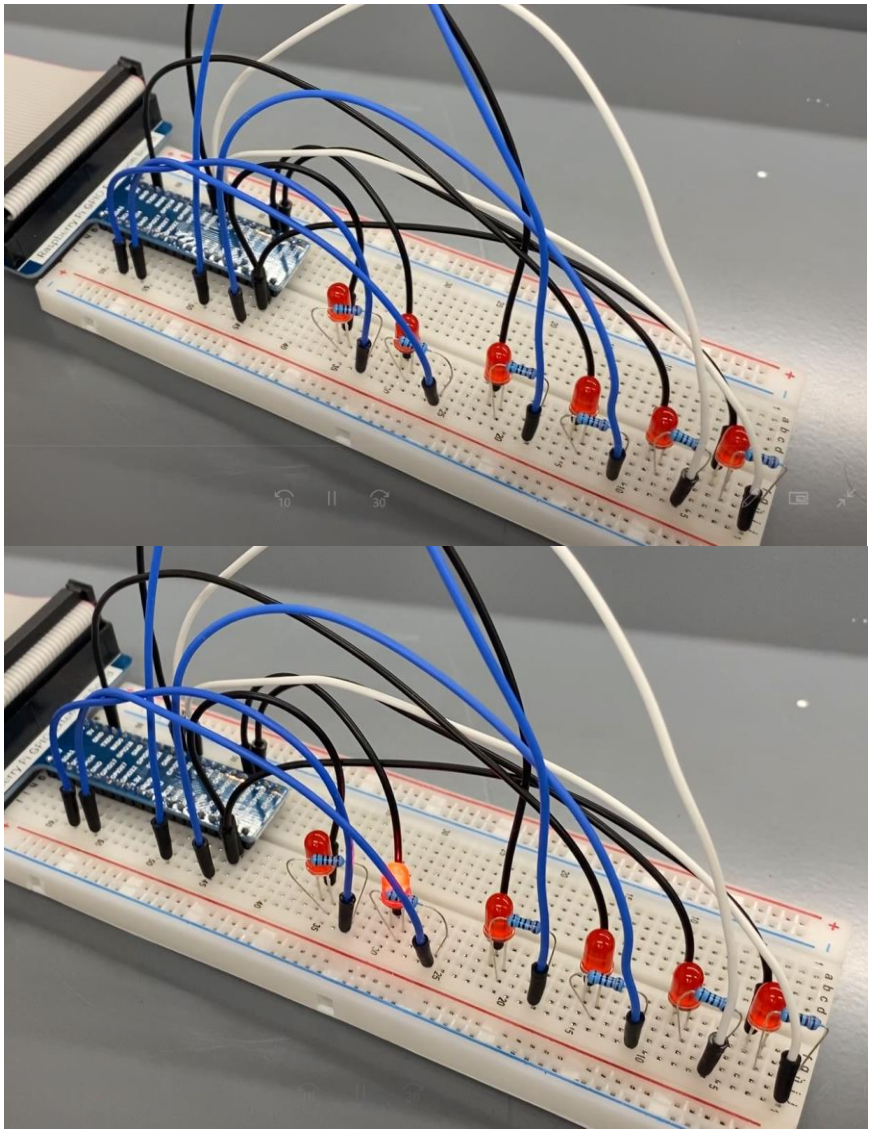
The Laboratory Assignments:

Extend the above experiment to more complicated situations:

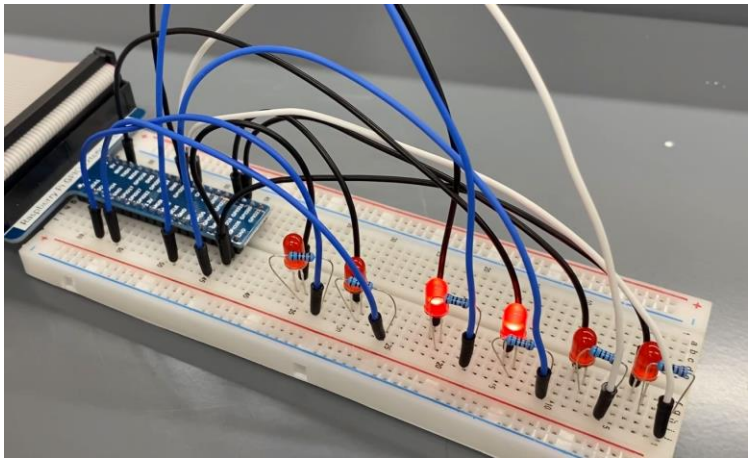
Please find the video I uploaded for the detailed process.

1. Design program to blink one LED and shift back and forth among *6* LEDs.

```
import RPi.GPIO as GPIO
import time

ledList = [11, 15, 29, 37, 18, 22]
#ledPin = 11 # define ledPin
def setup():
    GPIO.setmode(GPIO.BOARD) # use PHYSICAL GPIO Numbering
    for ledPin in ledList:
        GPIO.setup(ledPin, GPIO.OUT) # set the ledPin to OUTPUT mode
        GPIO.output(ledPin, GPIO.LOW) # make ledPin output LOW level
        #print ('using pin%d'%ledPin)

def loop():
    i = 0
    n = len(ledList)
    forth = True
    while True:
            if i == 0:
                forth = True
            if i == n - 1:
                forth = False
            ledPin = ledList[i]
            GPIO.output(ledPin, GPIO.HIGH) # make ledPin output HIGH level to turn on led
            #print ('led turned on >>>') # print information on terminal
            time.sleep(1) # Wait for 1 second
            GPIO.output(ledPin, GPIO.LOW) # make ledPin output LOW level to turn off led
            #print ('led turned off <<<')
            #time.sleep(1) # Wait for 1 second
            if forth:
                i += 1
            else:
                i -= 1

def destroy():
    GPIO.cleanup() # Release all GPIO

if __name__ == '__main__': # Program entrance
    print ('Program is starting ... \n')
    setup()
    try:
        loop()
    except KeyboardInterrupt: # Press ctrl-c to end the program.
        destroy()
```



2 Make *2* LEDs at the two ends of *6* LEDs on the board blink and move in different directions and back.



```
import RPi.GPIO as GPIO
import time

ledList = [11, 15, 29, 37, 18, 22]
#ledPin = 11 # define ledPin
def setup():
    GPIO.setmode(GPIO.BOARD) # use PHYSICAL GPIO Numbering
    for ledPin in ledList:
        GPIO.setup(ledPin, GPIO.OUT) # set the ledPin to OUTPUT mode
        GPIO.output(ledPin, GPIO.LOW) # make ledPin output LOW level
        #print ('using pin%d'%ledPin)

def loop():

    n = len(ledList)
    left,right = 0, n -1
    forth = True

    while True:
            if left == 0:
                forth = True
            if left == n - 1:
                forth = False

            ledPin0 = ledList[left]
            ledPin1 = ledList[right]
            GPIO.output(ledPin0, GPIO.HIGH) # make ledPin output HIGH level to turn on led
            GPIO.output(ledPin1, GPIO.HIGH) # make ledPin output HIGH level to turn on led
            time.sleep(1) # Wait for 1 second
            GPIO.output(ledPin0, GPIO.LOW) # make ledPin output LOW level to turn off led
            GPIO.output(ledPin1, GPIO.LOW) # make ledPin output LOW level to turn off led
            time.sleep(1) # Wait for 1 second

            if forth:
                left += 1
                right -= 1
            else:
                left -= 1
                right += 1


def destroy():
    GPIO.cleanup() # Release all GPIO

if __name__ == '__main__': # Program entrance
    print ('Program is starting ... \n')
    setup()
    try:
        loop()
    except KeyboardInterrupt: # Press ctrl-c to end the program.
        destroy()
```

3 Make *2* LEDs in the center blink in different directions and move back.

```
import RPi.GPIO as GPIO
import time

ledList = [11, 15, 29, 37, 18, 22]
#ledPin = 11 # define ledPin
def setup():
    GPIO.setmode(GPIO.BOARD) # use PHYSICAL GPIO Numbering
    for ledPin in ledList:
        GPIO.setup(ledPin, GPIO.OUT) # set the ledPin to OUTPUT mode
        GPIO.output(ledPin, GPIO.LOW) # make ledPin output LOW level
        #print ('using pin%d'%ledPin)

def loop():

    n = len(ledList)
    left,right = 0, n -1
    forth = True

    while True:
            if left == 0:
                forth = True
            if left == n/2 - 1:
                forth = False

            ledPin0 = ledList[left]
            ledPin1 = ledList[right]
            GPIO.output(ledPin0, GPIO.HIGH) # make ledPin output HIGH level to turn on led
            GPIO.output(ledPin1, GPIO.HIGH) # make ledPin output HIGH level to turn on led
            time.sleep(1) # Wait for 1 second
            GPIO.output(ledPin0, GPIO.LOW) # make ledPin output LOW level to turn off led
            GPIO.output(ledPin1, GPIO.LOW) # make ledPin output LOW level to turn off led
            time.sleep(1) # Wait for 1 second

            if forth:
                left += 1
                right -= 1
            else:
                left -= 1
                right += 1


def destroy():
    GPIO.cleanup() # Release all GPIO

if __name__ == '__main__': # Program entrance
    print ('Program is starting ... \n')
    setup()
    try:
        loop()
    except KeyboardInterrupt: # Press ctrl-c to end the program.
        destroy()
```