微算機系統實習

第 13 組專案報告

LAB 04

GPIO 遠端週邊控制實習

組別： 13

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日期：2024.04.16

一、實驗內容：

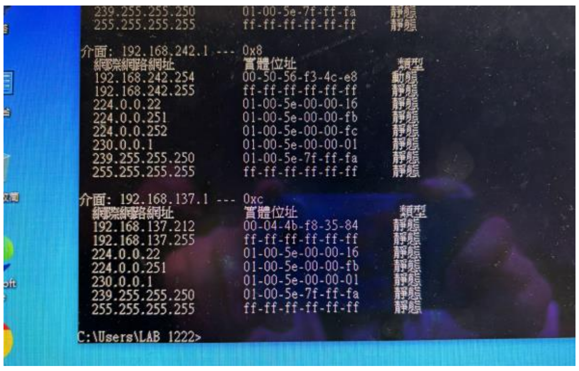
1. 利用 Nodejs 架設 web 伺服器
2. 安裝 npm 開源套件
3. 撰寫 html 基礎語法
4. 了解前後端參數傳遞概念
5. 利用 child_process 執行子程序
6. 學習透過 CGI 網頁，控制 GPIO 上的 LED 燈
   a. 項目一：利用 Nodejs 架設 web 伺服器(20%)
      i. 撰寫 html 及後端程式
      ii. 在 TX2 上架設 web 伺服器
      iii. 能在電腦瀏覽器上查看網頁
   b. 項目二：網頁控制指定 LED 開關事件(25%)
      i. 4 顆 LED 燈狀態選項 (可選用 Check Box)
      ii. 燈亮、熄滅選項及 Submit 按鈕
      iii. 勾選指定 LED 燈號，點擊 Submit 即可控制 TX2 上的 LED
      iv. 點擊 Submit 後，需在原畫面顯示送出的狀態(在同個畫面)
   c. 項目三：網頁控制多顆 LED 同時閃爍(25%)
      i. 須有 input 欄位可以輸入指定閃爍次數
      ii. 預設按鈕名稱為 Mode_Shine
      iii. 點擊後，依據指定閃爍次數，以間隔閃爍 2 組 LED

(* 以上皆必須能在瀏覽器上操作)

二、實驗過程及結果：

1. 實驗過程

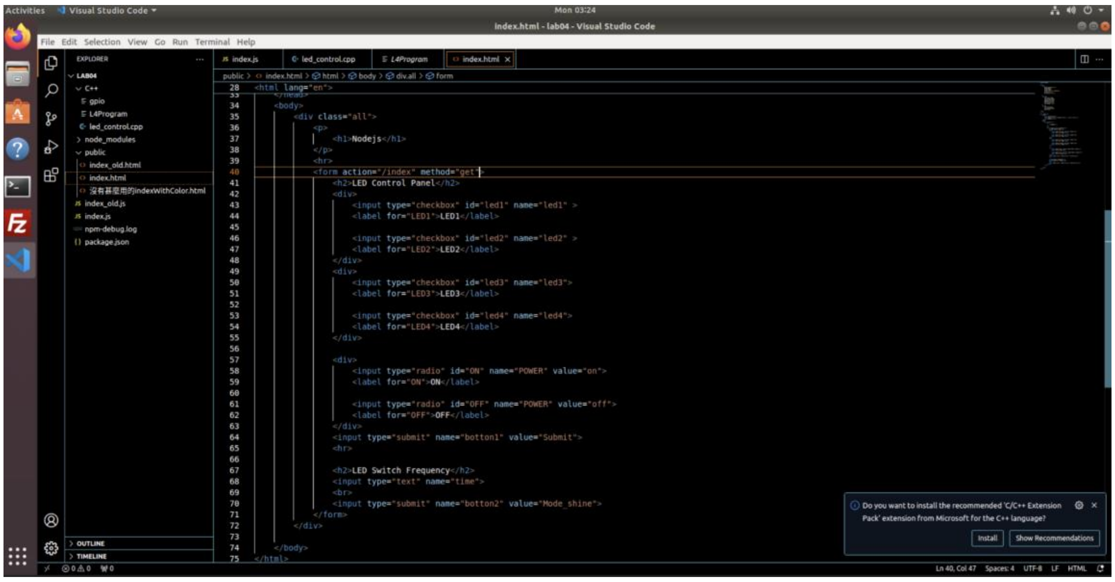
   因為本實驗在 tx2 需共用網路，所以需使用網路線來進行連接，可在 cmd 輸入指令查看對應 tx2 ip，此 ip 之後可在瀏覽器進行輸入來查看網頁



```
  239.255.255.250       01-00-5e-7f-ff-fa     靜態
  255.255.255.255       ff-ff-ff-ff-ff-ff     靜態

介面: 192.168.242.1 --- 0x8
  網際網路網址          實體位址              類型
  192.168.242.254       00-50-56-f3-4c-e8     動態
  192.168.242.255       ff-ff-ff-ff-ff-ff     靜態
  224.0.0.22            01-00-5e-00-00-16     靜態
  224.0.0.251           01-00-5e-00-00-fb     靜態
  224.0.0.252           01-00-5e-00-00-fc     靜態
  230.0.0.1             01-00-5e-00-00-01     靜態
  239.255.255.250       01-00-5e-7f-ff-fa     靜態
  255.255.255.255       ff-ff-ff-ff-ff-ff     靜態

介面: 192.168.137.1 --- 0xc
  網際網路網址          實體位址              類型
  192.168.137.212       00-04-4b-f8-35-84     靜態
  192.168.137.255       ff-ff-ff-ff-ff-ff     靜態
  224.0.0.22            01-00-5e-00-00-16     靜態
  224.0.0.251           01-00-5e-00-00-fb     靜態
  230.0.0.1             01-00-5e-00-00-01     靜態
  239.255.255.250       01-00-5e-7f-ff-fa     靜態
  255.255.255.255       ff-ff-ff-ff-ff-ff     靜態

C:\Users\LAB 1222>
```

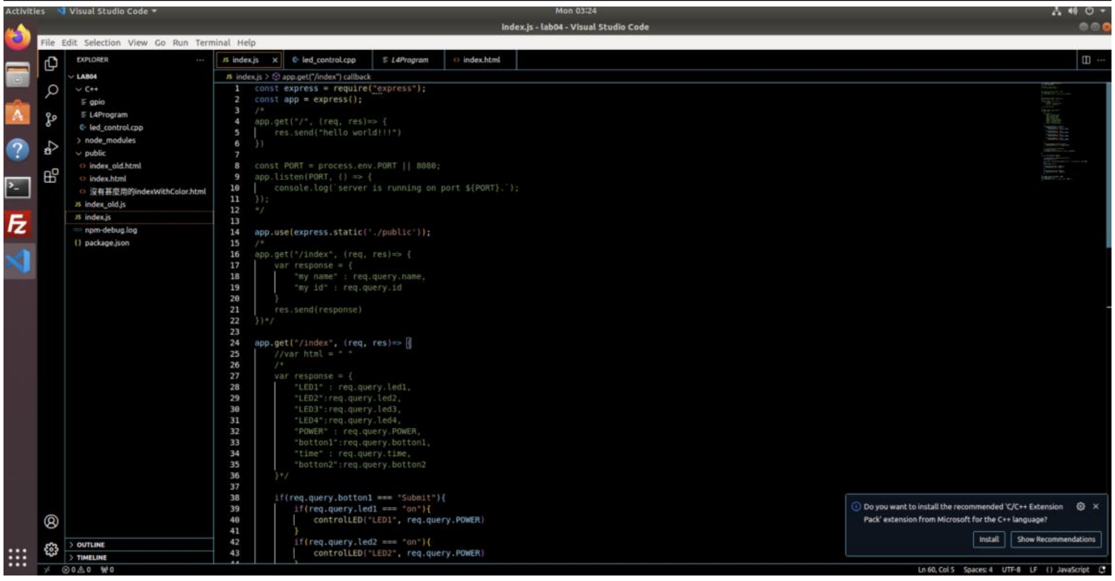
(1)項目一

(a)　撰寫 html 及後端程式


index.html - lab04 - Visual Studio Code

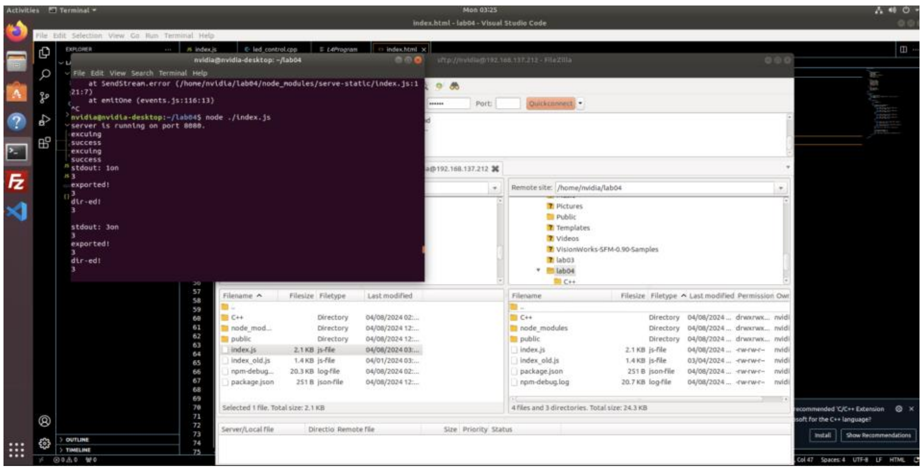
```html
<html lang="en">
    <body>
        <div class="all">
            <p>
                <h1>Nodejs</h1>
            </p>
            <hr>
            <form action="/index" method="get">
                <h2>LED Control Panel</h2>
                <div>
                    <input type="checkbox" id="led1" name="led1" >
                    <label for="LED1">LED1</label>

                    <input type="checkbox" id="led2" name="led2" >
                    <label for="LED2">LED2</label>
                </div>
                <div>
                    <input type="checkbox" id="led3" name="led3">
                    <label for="LED3">LED3</label>

                    <input type="checkbox" id="led4" name="led4">
                    <label for="LED4">LED4</label>
                </div>

                <div>
                    <input type="radio" id="ON" name="POWER" value="on">
                    <label for="ON">ON</label>

                    <input type="radio" id="OFF" name="POWER" value="off">
                    <label for="OFF">OFF</label>
                </div>
                <input type="submit" name="botton1" value="Submit">
                <hr>

                <h2>LED Switch Frequency</h2>
                <input type="text" name="time">
                <br>
                <input type="submit" name="botton2" value="Mode_shine">
            </form>
        </div>

    </body>
</html>
```

Do you want to install the recommended 'C/C++ Extension Pack' extension from Microsoft for the C++ language?


index.js - lab04 - Visual Studio Code

```javascript
const express = require("express");
const app = express();
/*
app.get("/", (req, res)=> {
    res.send("hello world!!!")
})

const PORT = process.env.PORT || 8080;
app.listen(PORT, () => {
    console.log(`server is running on port ${PORT}.`);
});
*/

app.use(express.static('./public'));
/*
app.get("/index", (req, res)=> {
    var response = {
        "my name" : req.query.name,
        "my id" : req.query.id
    }
    res.send(response)
})*/

app.get("/index", (req, res)=> {
    //var html = " "
    /*
    var response = {
        "LED1" : req.query.led1,
        "LED2":req.query.led2,
        "LED3":req.query.led3,
        "LED4":req.query.led4,
        "POWER" : req.query.POWER,
        "botton1":req.query.botton1,
        "time" : req.query.time,
        "botton2":req.query.botton2
    }*/

    if(req.query.botton1 === "Submit"){
        if(req.query.led1 === "on"){
            controlLED("LED1", req.query.POWER)
        }
        if(req.query.led2 === "on"){
            controlLED("LED2", req.query.POWER)
```

(b)　在 TX2 上架設 web 伺服器


nvidia@nvidia-desktop: ~/lab04

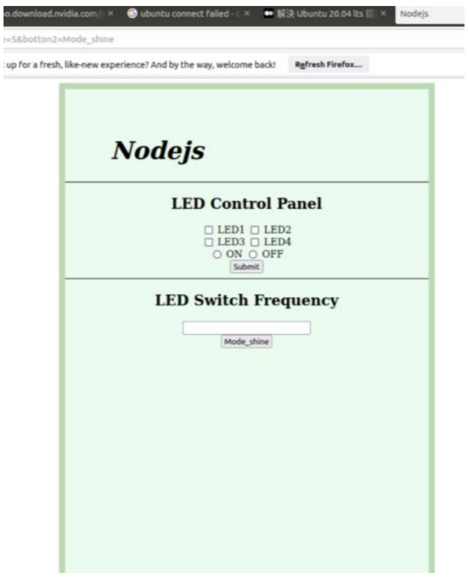
```
    at SendStream.error (/home/nvidia/lab04/node_modules/serve-static/index.js:1
21:7)
    at emitOne (events.js:116:13)
^C
nvidia@nvidia-desktop:~/lab04$ node ./index.js
server is running on port 8080.
excuing
success
excuing
success
stdout: 1on
3
exported!
3
dir-ed!
3

stdout: 3on
3
exported!
3
dir-ed!
3
```

Remote site: /home/nvidia/lab04

Filename	Filesize	Filetype	Last modified	Permission
..				
C++		Directory	04/08/2024 ...	drwxrwx...
node_modules		Directory	04/08/2024 ...	drwxrwx...
public		Directory	04/08/2024 ...	drwxrwx...
index.js	2.1 KB	js-file	04/08/2024 ...	-rw-rw-r--
index_old.js	1.4 KB	js-file	03/04/2024 ...	-rw-rw-r--
package.json	251 B	json-file	04/08/2024 ...	-rw-rw-r--
npm-debug.log	20.7 KB	log-file	04/08/2024 ...	-rw-rw-r--

4 files and 3 directories. Total size: 24.3 KB

（c）　能在電腦瀏覽器上查看網頁



Nodejs

LED Control Panel

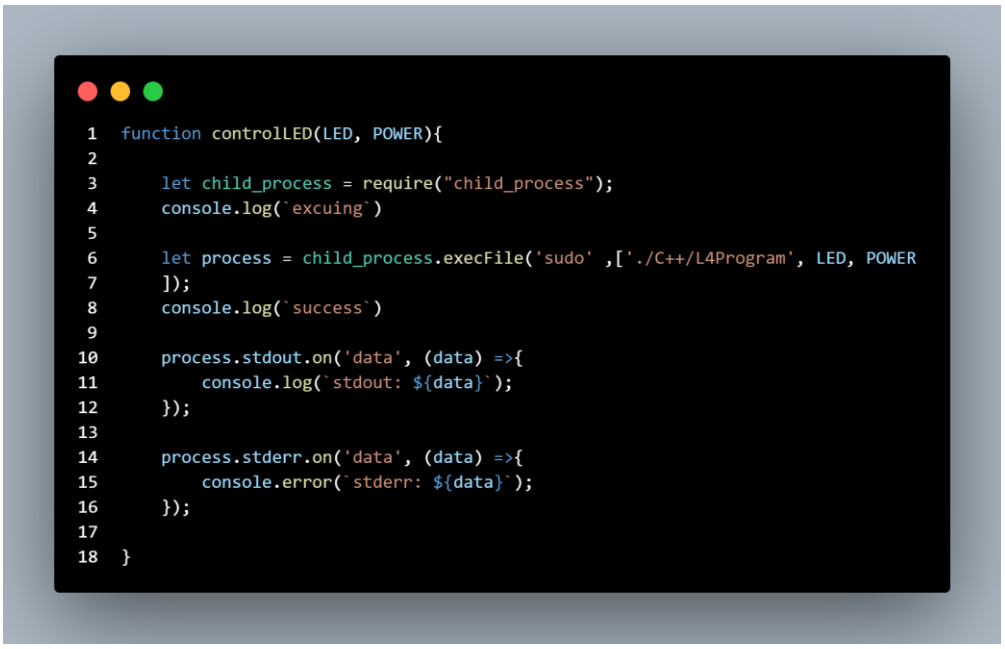
☐ LED1 ☐ LED2
☐ LED3 ☐ LED4
○ ON ○ OFF
Submit

LED Switch Frequency

Mode_shine

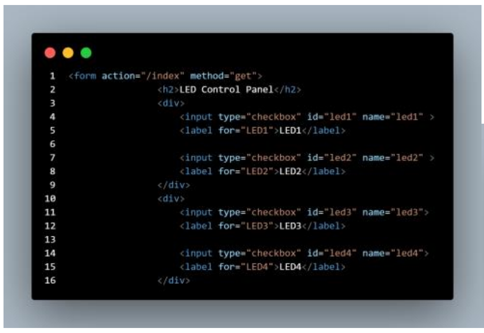
(2)項目二

進行 LED 操作的子程式如下。其中 L4Program 為 led_control.cpp 編譯出來的執行檔。

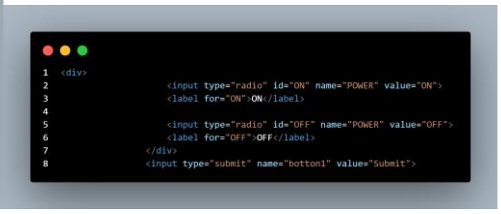


```
function controlLED(LED, POWER){

    let child_process = require("child_process");
    console.log(`excuing`)

    let process = child_process.execFile('sudo' ,['./C++/L4Program', LED, POWER
    ]);
    console.log(`success`)

    process.stdout.on('data', (data) =>{
        console.log(`stdout: ${data}`);
    });

    process.stderr.on('data', (data) =>{
        console.error(`stderr: ${data}`);
    });

}
```

i. html(checkbox & radio & button)

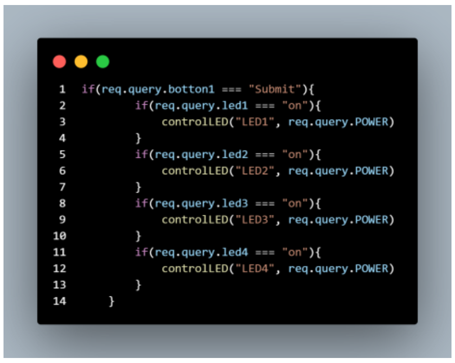


```
<form action="/index" method="get">
                <h2>LED Control Panel</h2>
                <div>
                    <input type="checkbox" id="led1" name="led1" >
                    <label for="LED1">LED1</label>

                    <input type="checkbox" id="led2" name="led2" >
                    <label for="LED2">LED2</label>
                </div>
                <div>
                    <input type="checkbox" id="led3" name="led3">
                    <label for="LED3">LED3</label>

                    <input type="checkbox" id="led4" name="led4">
                    <label for="LED4">LED4</label>
                </div>
```



```
<div>
                    <input type="radio" id="ON" name="POWER" value="ON">
                    <label for="ON">ON</label>

                    <input type="radio" id="OFF" name="POWER" value="OFF">
                    <label for="OFF">OFF</label>
                </div>
                <input type="submit" name="botton1" value="Submit">
```

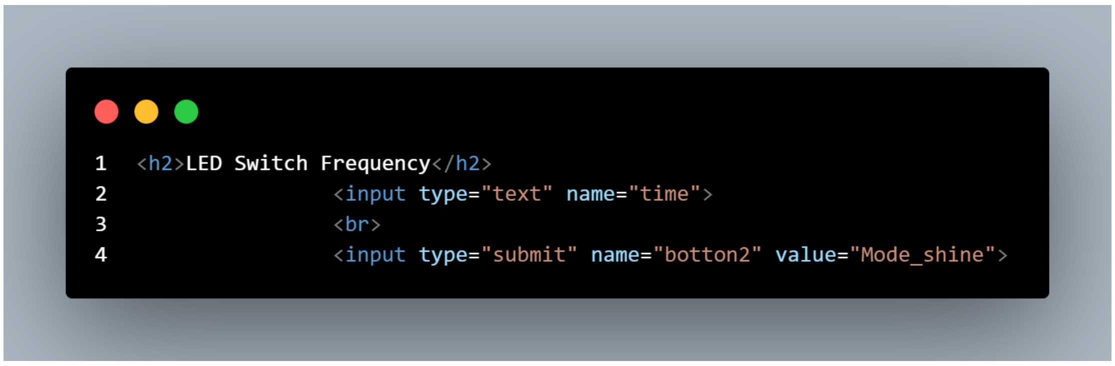
ii. js



```
if(req.query.botton1 === "Submit"){
        if(req.query.led1 === "on"){
            controlLED("LED1", req.query.POWER)
        }
        if(req.query.led2 === "on"){
            controlLED("LED2", req.query.POWER)
        }
        if(req.query.led3 === "on"){
            controlLED("LED3", req.query.POWER)
        }
        if(req.query.led4 === "on"){
            controlLED("LED4", req.query.POWER)
        }
    }
```

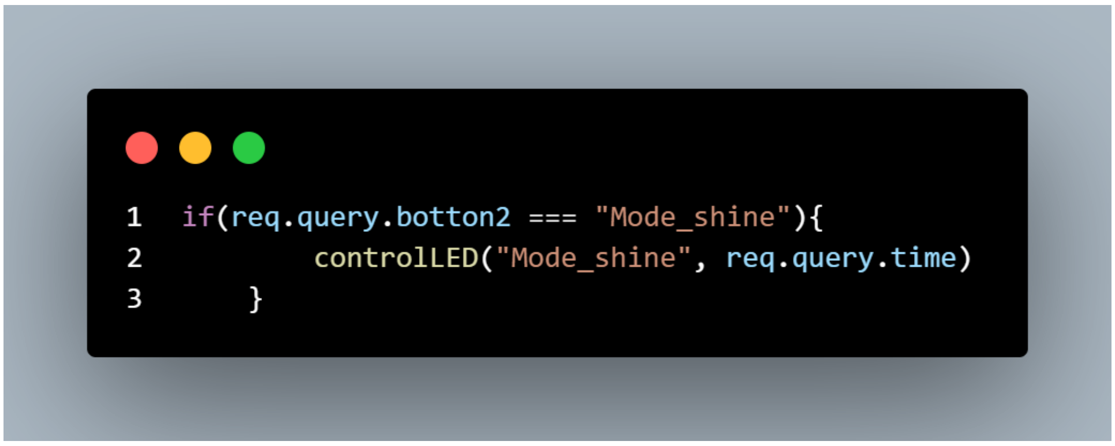
(3)項目三

i. html(text & button)



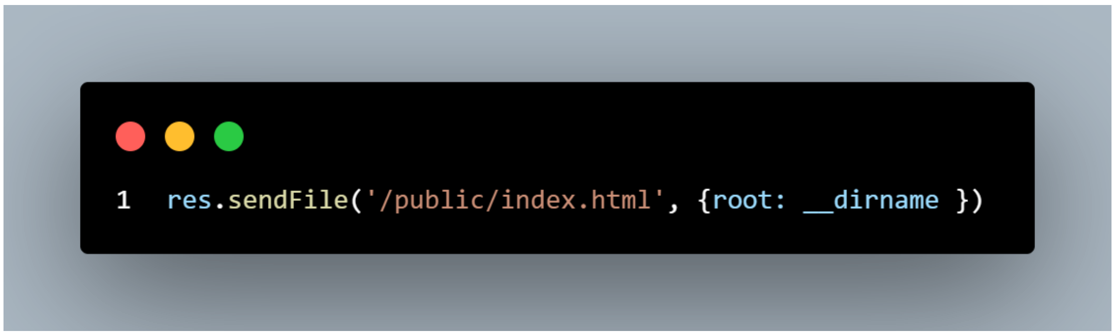
```
<h2>LED Switch Frequency</h2>
                <input type="text" name="time">
                <br>
                <input type="submit" name="botton2" value="Mode_shine">
```

ii. js



```
if(req.query.botton2 === "Mode_shine"){
          controlLED("Mode_shine", req.query.time)
      }
```

※ 最後回傳



```
res.sendFile('/public/index.html', {root: __dirname })
```

2. 預期實驗結果

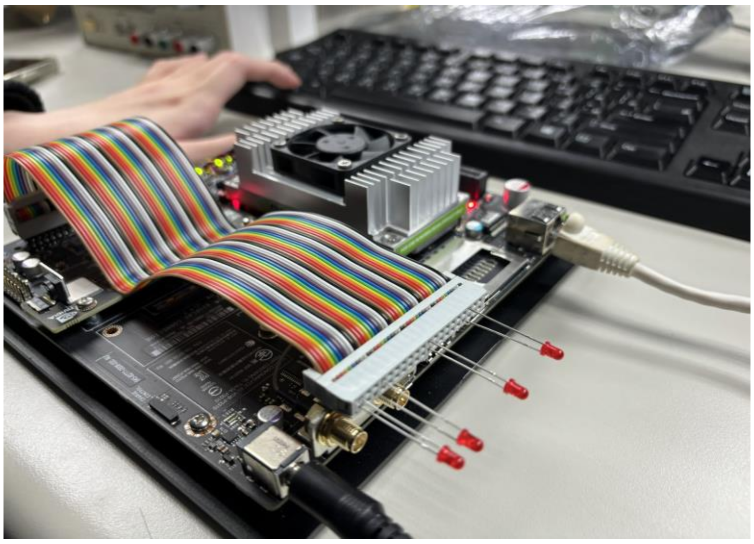
能在 tx2 的電腦瀏覽器上查看網頁，並利用所寫網頁控制指定 led 開關事件(利用 checkbox 選擇目標 led、radio 勾選 ON or OFF，並按鍵提交)，可勾選燈亮或熄滅再按提交。提交後 tx2 上相應的 led 會做出對應動作。

另外，可於 input 欄位輸入指定閃爍次數，並點擊按鍵來控制間隔閃爍 2 組 led 的次數。

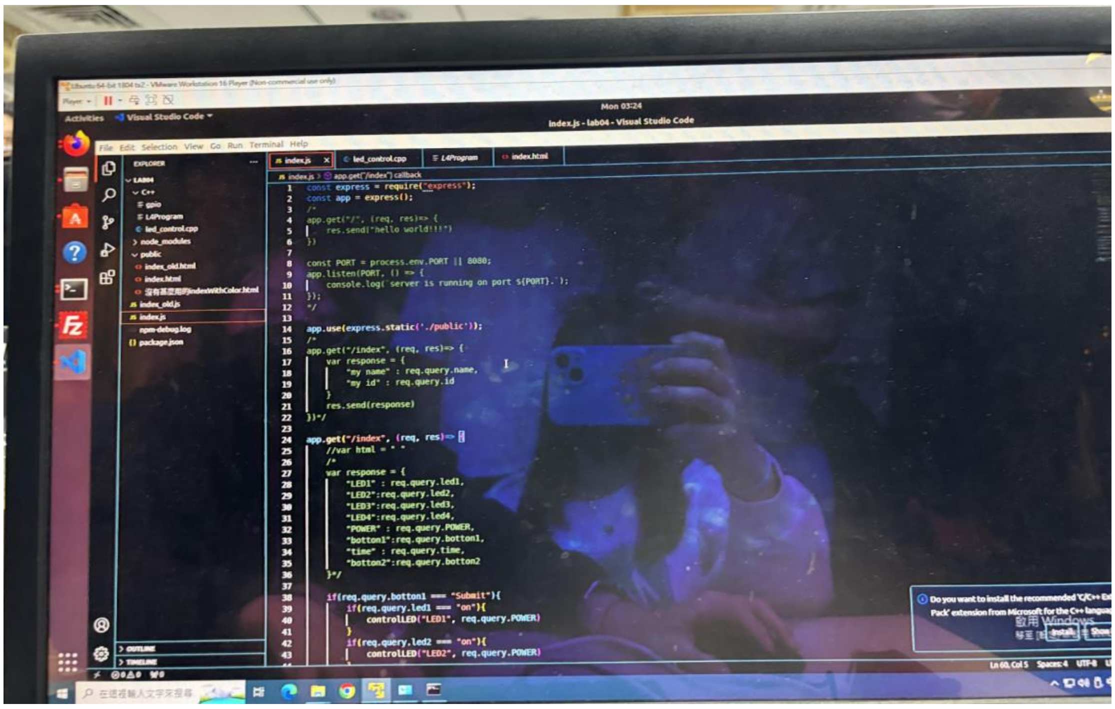
3. 實際上的結果

https://drive.google.com/file/d/1zYEFGyqG9nopRhrkEPGTjE1L5FhhrNxs/view?usp=drive_link（操作影片連結）

(1)led 接到 tx2

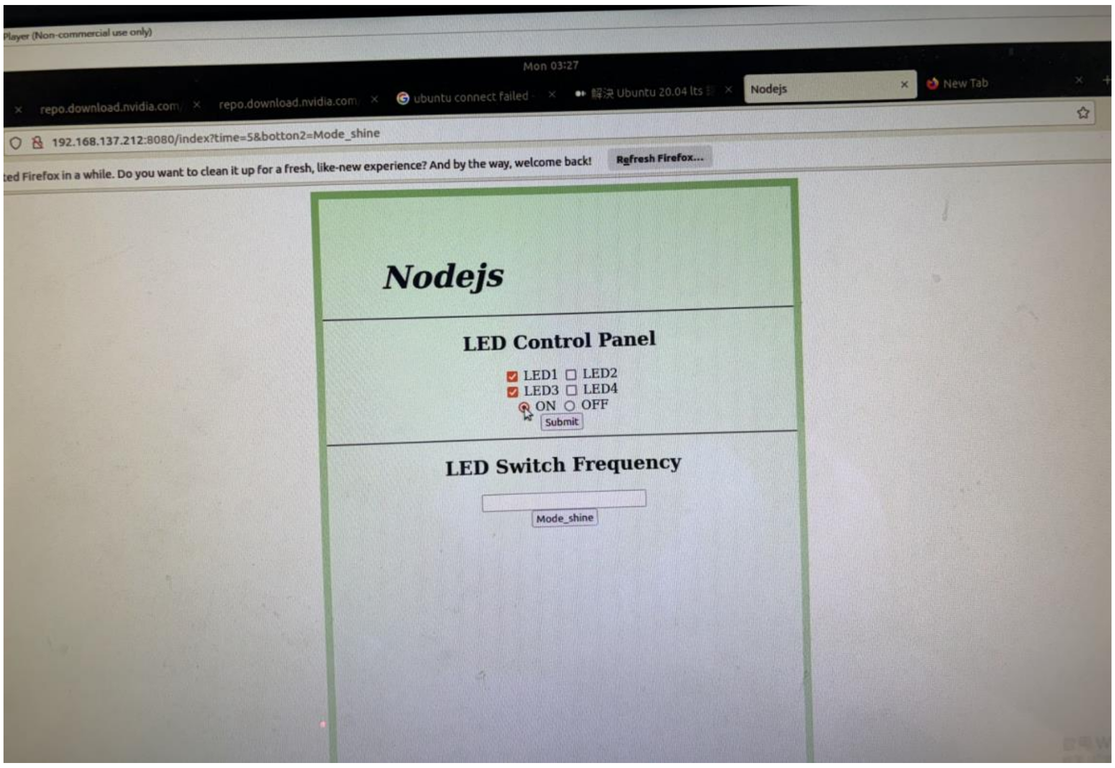


(2)程式碼畫面

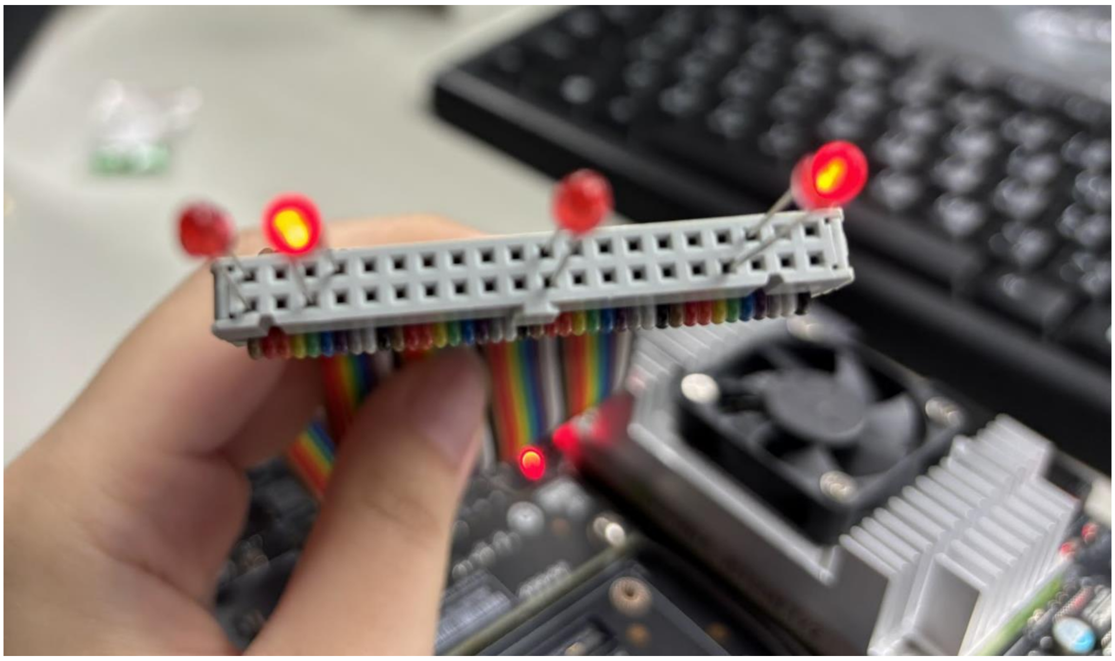


```
const express = require("express");
const app = express();
/*
app.get("/", (req, res)=> {
    res.send("hello world!!!")
})

const PORT = process.env.PORT || 8080;
app.listen(PORT, () => {
    console.log(`server is running on port ${PORT}.`);
});
*/

app.use(express.static('./public'));
/*
app.get("/index", (req, res)=> {
    var response = {
        "my name" : req.query.name,
        "my id" : req.query.id
    }
    res.send(response)
})*/

app.get("/index", (req, res)=> {
    //var html = " "
    /*
    var response = {
        "LED1" : req.query.led1,
        "LED2":req.query.led2,
        "LED3":req.query.led3,
        "LED4":req.query.led4,
        "POWER" : req.query.POWER,
        "botton1":req.query.botton1,
        "time" : req.query.time,
        "botton2":req.query.botton2
    }*/

    if(req.query.botton1 === "Submit"){
        if(req.query.led1 === "on"){
            controlLED("LED1", req.query.POWER)
        }
        if(req.query.led2 === "on"){
            controlLED("LED2", req.query.POWER)
```

(3)實際在瀏覽器操作



(4)控制 led 亮燈畫面



4. 遇到的問題&問題怎麼解決

(1) 不會寫前後端，只能自己想辦法上網查

(2) tx2 沒網路，網路共用設置相反導致抓不到 ip，後來跑回去翻講義才設置好

(3) 在最後為了不讓頁面跳開，花了很多時間嘗試，最後還是選擇直接回傳 html 檔案

三、程式碼

index. js

```
const express = require("express");
const app = express();
/*
app.get("/", (req, res)=> {
    res.send("hello world!!!")
})

const PORT = process.env.PORT || 8080;
app.listen(PORT, () => {
    console.log(`server is running on port ${PORT}.`);
});
*/

app.use(express.static('./public'));
/*
app.get("/index", (req, res)=> {
    var response = {
        "my name" : req.query.name,
        "my id" : req.query.id
    }
    res.send(response)
})*/

app.get("/index", (req, res)=> {
    //var html = " "
    /*
    var response = {
        "LED1" : req.query.led1,
        "LED2":req.query.led2,
        "LED3":req.query.led3,
        "LED4":req.query.led4,
        "POWER" : req.query.POWER,
        "botton1":req.query.botton1,
        "time" : req.query.time,
        "botton2":req.query.botton2
    }*/

    if(req.query.botton1 === "Submit"){
        if(req.query.led1 === "on"){
            controlLED("LED1", req.query.POWER)
        }
        if(req.query.led2 === "on"){
            controlLED("LED2", req.query.POWER)
        }
        if(req.query.led3 === "on"){
            controlLED("LED3", req.query.POWER)
        }
        if(req.query.led4 === "on"){
            controlLED("LED4", req.query.POWER)
        }
    }

    if(req.query.botton2 === "Mode_shine"){
        controlLED("Mode_shine", req.query.time)
    }

    //res.send("Successfully Requested")
    //res.send('response')
    res.sendFile('/public/index.html', {root: __dirname })

})

function controlLED(LED, POWER){

    let child_process = require("child_process");
    console.log(`excuing`)

    let process =
child_process.execFile('sudo' ,['./C++/L4Program', LED, POWER
    ]);
    console.log(`success`)

    process.stdout.on('data', (data) =>{
        console.log(`stdout: ${data}`);
    });

    process.stderr.on('data', (data) =>{
        console.error(`stderr: ${data}`);
    });

}
const PORT = process.env.PORT || 8080;
app.listen(PORT, () => {
    console.log(`server is running on port ${PORT}.`);
});

        if(req.query.led2 === "on"){
            controlLED("LED2", req.query.POWER)
        }
        if(req.query.led3 === "on"){
            controlLED("LED3", req.query.POWER)
        }
        if(req.query.led4 === "on"){
            controlLED("LED4", req.query.POWER)
        }
    }

    if(req.query.botton2 === "Mode_shine"){
        controlLED("Mode_shine", req.query.time)
    }

    //res.send("Successfully Requested")
    //res.send('response')
    res.sendFile('/public/index.html', {root: __dirname })

})

function controlLED(LED, POWER){

    let child_process = require("child_process");
    console.log(`excuing`)

    let process =
child_process.execFile('sudo' ,['./C++/L4Program', LED, POWER
    ]);
    console.log(`success`)

    process.stdout.on('data', (data) =>{
        console.log(`stdout: ${data}`);
    });

    process.stderr.on('data', (data) =>{
        console.error(`stderr: ${data}`);
    });

}
const PORT = process.env.PORT || 8080;
app.listen(PORT, () => {
    console.log(`server is running on port ${PORT}.`);
});
```

index.html

```
<!DOCTYPE html>

<style>
    .all{
        background:#e8fcef;
        width:600px;
        height:800px;
        border:10px solid #b3dbb1;
        margin:0 auto;
        text-align: center;

    }
    .all h1{
        font-size: 40px;
        font-weight:500px;
        padding-left:75px;
        padding-top:50px;
        font-style:italic;
        text-align: left;
    }
    .all p{
        font-size:20px;
        font-weight:200px;
        opacity:0.5;
    }
</style>

<html lang="en">
    <head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=\, initial-
scale=1.0">
        <title>Nodejs</title>
    </head>
    <body>
        <div class="all">
            <p>
                <h1>Nodejs</h1>
            </p>
            <hr>
            <form action="/index" method="get">
                <h2>LED Control Panel</h2>
                <div>
                    <input type="checkbox" id="led1" name="led1"
>
                    <label for="LED1">LED1</label>

                    <input type="checkbox" id="led2" name="led2"
>
                    <label for="LED2">LED2</label>
                </div>
                <div>
                    <input type="checkbox" id="led3"
name="led3">
                    <label for="LED3">LED3</label>

                    <input type="checkbox" id="led4"
name="led4">
                    <label for="LED4">LED4</label>
                </div>

                <div>
                    <input type="radio" id="ON" name="POWER"
value="on">
                    <label for="ON">ON</label>
                    <input type="radio" id="OFF" name="POWER"
value="off">
                    <label for="OFF">OFF</label>
                </div>
                <input type="submit" name="botton1"
value="Submit">
                <hr>

                <h2>LED Switch Frequency</h2>
                <input type="text" name="time">
                <br>
                <input type="submit" name="botton2"
value="Mode_shine">
            </form>
        </div>

    </body>
</html>
```

led_control.cpp

```
#include <vector>
#include <iostream>
#include <string>
#include <string.h>
#include <stdlib.h>
#include <errno.h>
#include <unistd.h>
#include <fcntl.h>

using namespace std;

int gpio_export(unsigned int gpio);
int gpio_unexport(unsigned int gpio);
int gpio_set_dir(unsigned int gpio, string dirStatus);
int gpio_set_value(unsigned int gpio, int value);

int main(int argc, char *argv[]){
      cout << argv[1][3] << argv[2] << endl;
      if(argv[1][0] == 'L'){
      if(argv[2][1] == 'n'){
            switch(argv[1][3]){
            case '1':
                  gpio_export(396);
                  gpio_set_dir(396, "out");
                  gpio_set_value(396,1);
                  break;
            case '2':
                  gpio_export(429);
                  gpio_set_dir(429, "out");
                  gpio_set_value(429,1);
                  break;
            case '3':

                  gpio_export(395);
                  gpio_set_dir(395, "out");
                  gpio_set_value(395,1);
                  break;
            case '4':
                  gpio_export(393);
                  gpio_set_dir(393, "out");
                  gpio_set_value(393,1);
                  break;
      }}
      else{
            switch(argv[1][3]){
            case '1':
                  gpio_set_value(396, 0);
                  gpio_unexport(396);
                  break;
            case '2':
                  gpio_set_value(429, 0);
                  gpio_unexport(429);
                  break;
            case '3':
                  gpio_set_value(395, 0);
                  gpio_unexport(395);
                  break;
            case '4':
                  gpio_set_value(393, 0);
                  gpio_unexport(393);
                  break;
}
      }}
      else{
            int len = std::stoi(argv[2]);
      for (int i = 0; i < 2*len; i++){
            cout << "i:" << i << endl;
            if(i % 2 == 0){
                  gpio_export(396);
                  gpio_set_dir(396, "out");
                  gpio_set_value(396,1);
                  gpio_export(429);
                  gpio_set_dir(429, "out");
                  gpio_set_value(429,1);

                  gpio_set_value(395, 0);
                  gpio_unexport(395);
                  gpio_set_value(393, 0);
                  gpio_unexport(393);
                  sleep(1);
            }
            else{
                  gpio_export(395);
                  gpio_set_dir(395, "out");
                  gpio_set_value(395,1);
                  gpio_export(393);
                  gpio_set_dir(393, "out");
                  gpio_set_value(393,1);

                  gpio_set_value(396, 0);
                  gpio_unexport(396);
                  gpio_set_value(429, 0);
                  gpio_unexport(429);
                  sleep(1);
}
}
                  gpio_set_value(395, 0);
                  gpio_unexport(395);
                  gpio_set_value(393, 0);
                  gpio_unexport(393);
                  gpio_set_value(396, 0);
                  gpio_unexport(396);
                  gpio_set_value(429, 0);
                  gpio_unexport(429);
}

      return 0;
}


int gpio_set_value(unsigned int gpio, int value){
      int fd;
      char buf[64];

      snprintf(buf, sizeof(buf), "/sys/class/gpio/gpio%d/value",
gpio);

      fd = open(buf, O_WRONLY);
      cout << fd << endl;
      if(fd < 0){
            perror("gpio/value");
            return fd;
}
      if(value == 0)
            write(fd, "0", 2);
      else
            write(fd, "1", 2);
      close(fd);
      return 0;
}

int gpio_set_dir(unsigned int gpio, string dirStatus){
      int fd;
      char buf[64];

      snprintf(buf, sizeof(buf),
"/sys/class/gpio/gpio%d/direction", gpio);

      fd = open(buf, O_WRONLY);
      cout << fd << endl;
      if(fd < 0){
            perror("gpio/direction");
            return fd;
}
      if(dirStatus == "out")
            write(fd, "out", 4);
      else
            write(fd, "in", 3);

      close(fd);
      cout << "dir-ed!" << endl;
      return 0;
}

int gpio_unexport(unsigned int gpio){
      int fd, len;
      char buf[64];

      fd = open("/sys/class/gpio/unexport", O_WRONLY);
      if(fd <0){
            perror("gpio/export");
            return fd;
      }
      len = snprintf(buf, sizeof(buf), "%d", gpio);
      write(fd, buf, len);
      close(fd);
      return 0;
}

int gpio_export(unsigned int gpio){
      int fd, len;
      char buf[64];


      fd = open("/sys/class/gpio/export", O_WRONLY);
      cout << fd << endl;
      if(fd <0){
            perror("gpio/export");
            return fd;
      }
      len = snprintf(buf, sizeof(buf), "%d", gpio);
      write(fd, buf, len);
      close(fd);
      cout << "exported!" << endl;
      return 0;
}
```

四、本次實驗過程說明與解決方法:

1. 實驗過程

   撰寫前後端程式碼 → 連線 tx2 → 將專案目錄送到 tx2 → 確認 tx2 是否已安裝所需套件 → 在瀏覽器執行 → 測試是否符合目標

2. 解決方法

   遇到最大的問題還是對於網頁設計的不熟悉，最後也只能靠自己四處尋找資料來解決。

五、分工:

學號、組員	貢獻比例	工作內容
B812110004 葉芸茜	50%	文書處理、實驗設計與實作、程式規劃、測試與除錯
B812110011 湯青秀	50%	文書處理、實驗設計與實作、程式規劃、測試與除錯