Letter of Transmittal

EECS 3215 Project report: An interlinking embedded system with social media. This report was written on Monday, April 18, 2016.

This report shows how the interlinking embedded system with social media was achieved. Also, this report demonstrates the organization of the hardware/software of this embedded system, as well as how it works.

If you have any further questions, please do not hesitate to contact me at this email address: taidnt92@my.yorku.ca.

Sincerely,

Tai Dinh

Department of Electrical Engineering and Computer Science

EECS 3215

EMBEDDED SYSTEMS

2015-2016 Winter Term

Project Report

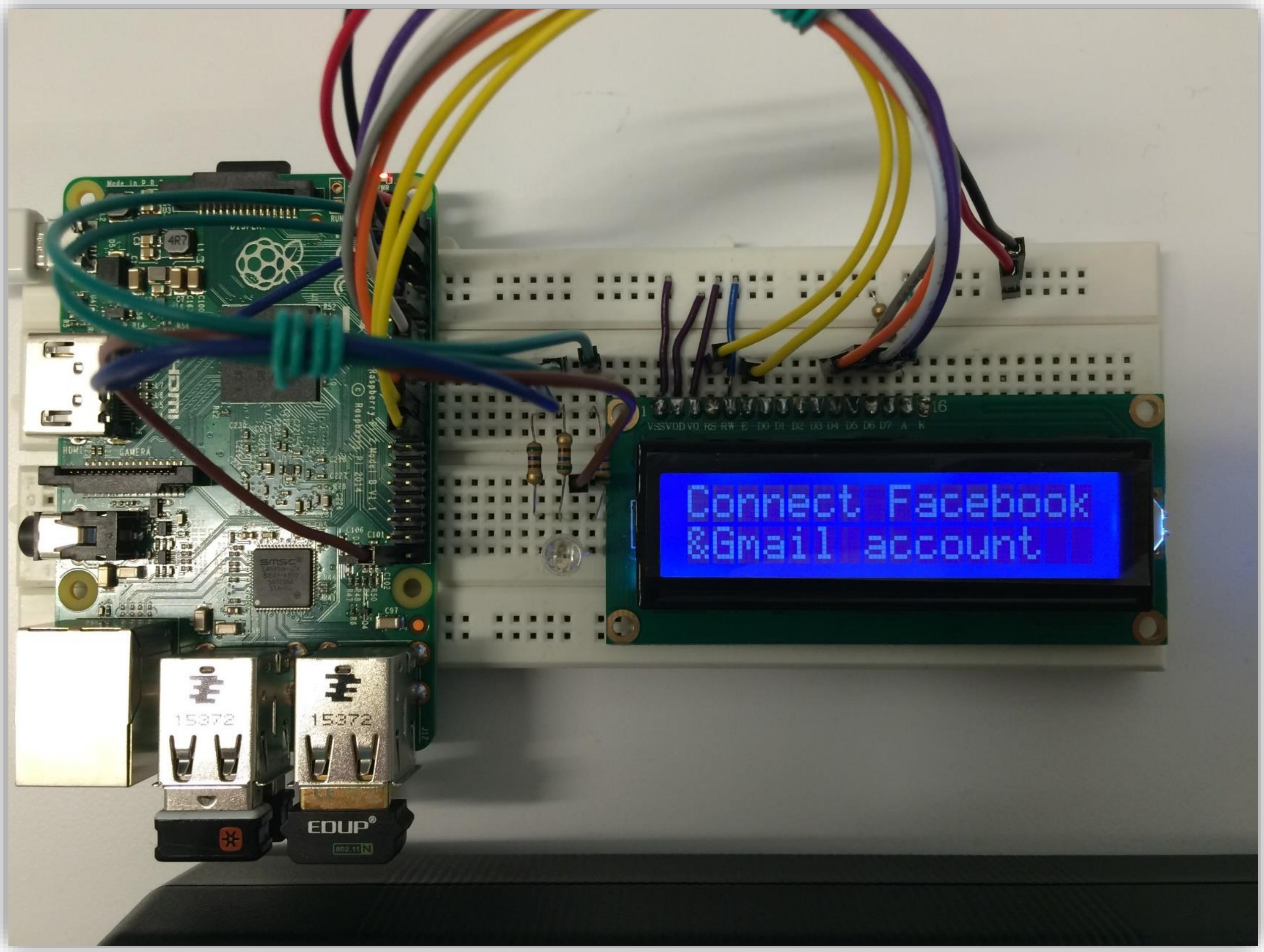
Amanpreet Singh Walia	*212938734*
Juan Gabriel Loja	*212786406*
Tai Dinh	*212501821*

Due Date: Tuesday, April 20, 2016

The work in this report is our own. We have read and understood York University's academic dishonesty policy and we did not violate the senate dishonesty policy in writing this report.

Signature

____



THE NOTIFIER

Executive Summary

This project report contains detailed description of our project with all the hardware and software components involved. This involves setup procedure, connections, software intricacies and the respective code involved. Our project is related to connecting Embedded systems with social media web to utilize the benefits of internet connected world as much as possible. For this particular project, we use Facebook and Gmail as the social media platform for showing the proof of concept. However, it can be extended suitably to nearly all other existing platforms. On Embedded systems side we chose Raspberry pi 2 running Raspbian OS as the device of our choice. For user interface we use 16X2 LCD and Wi-Fi module to achieve the task. All necessary information related to project is available in detailed format across the report.

Acknowledgements

Working on this project was a source of immense knowledge to us. We would like to express our sincere, grateful gratitude to our instructor and teaching assistants for their guidance and valuable support in this project. This project cannot be completed without the effort and co-operation from our group members. We would also like to thank our parents for their love and support.

Amanpreet Walia

Juan Gabriel Loja

Tai Dinh

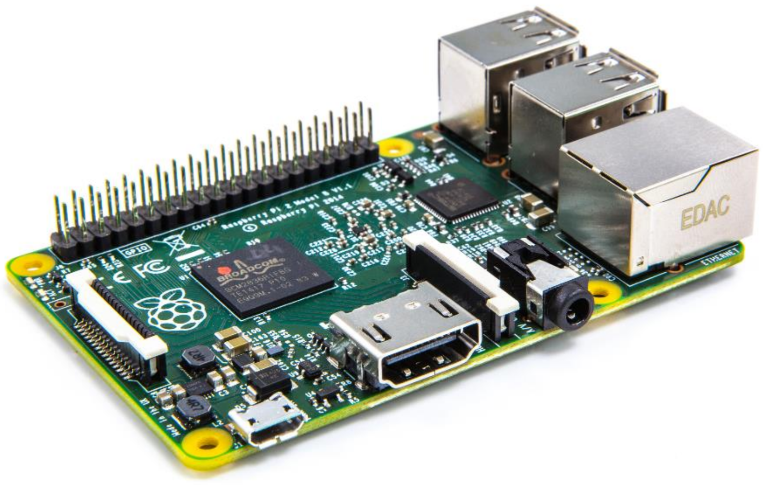
Introduction

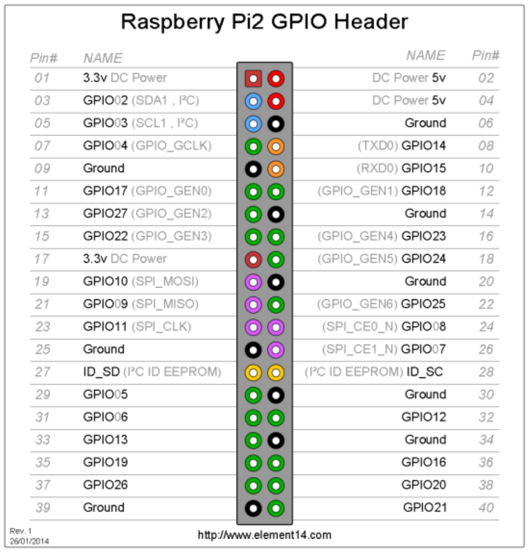
Today Social media connects nearly 2 billion people online through various platforms like Email & Social media messages and notifications (Twitter, Facebook, Gmail etc.). This generates a lot of useful data from our day to day lives which can be used to modernize our life in a better way. With this project we connected the realms of social media with embedded systems. Our present project offers a proof of concept that with IOT (Internet of Things) going popular we can connect very small embedded devices used in our day to day lives to social media through internet. This offers us smart devices which can use data generated by users on various web platforms to perform meaningful and intelligent tasks. For example, we can easily monitor the heart rate and blood pressure using various embedded devices but this information is limited to the patient itself. However, with these devices connected to social media we can have smart medical devices which can inform nearest medical authority in case of any emergency by fetching location data through social media. This task can be easily done using a social media platform.

For this particular project we have demonstrated that how communication is possible between an embedded device and social media. Our project utilizes raspberry pi which receives updates from Facebook/Twitter/Gmail based on notifications, messages and friend requests. The updates could be displayed on LCD module, as well indicated by a multi colored LED. This embedded system design includes the following components: Raspberry Pi 2 board, Wi-Fi module, LCD module, LEDs, Breadboard, female - male wires. This report presents the hardware with all schematics and explanation of design, as well as software with all program source and explanations.

Hardware Components and Schematics

Raspberry Pi





Raspberry Pi2 GPIO Header

Pin#	NAME			NAME	Pin#
01	3.3v DC Power	🟥	🔴	DC Power 5v	02
03	GPIO02 (SDA1 , I²C)	🔵	🔴	DC Power 5v	04
05	GPIO03 (SCL1 , I²C)	🔵	⚫	Ground	06
07	GPIO04 (GPIO_GCLK)	🟢	🟠	(TXD0) GPIO14	08
09	Ground	⚫	🟠	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	🟢	🟢	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	🟢	⚫	Ground	14
15	GPIO22 (GPIO_GEN3)	🟢	🟢	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	🔴	🟢	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	🟣	⚫	Ground	20
21	GPIO09 (SPI_MISO)	🟣	🟢	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	🟣	🟣	(SPI_CE0_N) GPIO08	24
25	Ground	⚫	🟣	(SPI_CE1_N) GPIO07	26
27	ID_SD (I²C ID EEPROM)	🟡	🟡	(I²C ID EEPROM) ID_SC	28
29	GPIO05	🟢	⚫	Ground	30
31	GPIO06	🟢	🟢	GPIO12	32
33	GPIO13	🟢	⚫	Ground	34
35	GPIO19	🟢	🟢	GPIO16	36
37	GPIO26	🟢	🟢	GPIO20	38
39	Ground	⚫	🟢	GPIO21	40

Rev. 1
26/01/2014
http://www.element14.com

Pin Diagram

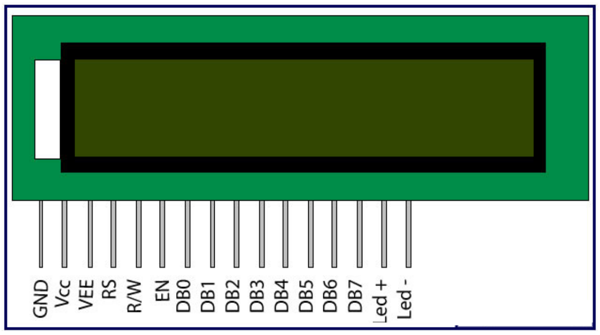
The Raspberry Pi 2 Model B is the second generation Raspberry Pi. It contains:

- A 900MHz quad-core ARM Cortex-A7 CPU
- 1GB RAM
- 4 USB ports
- 40 GPIO pins
- Full HDMI port
- Ethernet port
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- Video Core IV 3D graphics core

It has an ARMv7 processor which can run the full range of ARM GNU/Linux distributions, including Snappy Ubuntu Core, as well as Microsoft Windows 10.

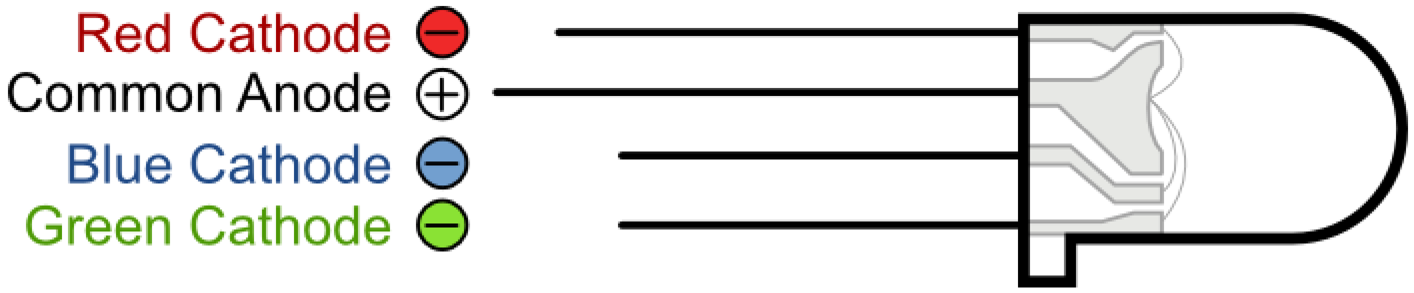
16x2 Liquid Crystal Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.



Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

RGB LED



Diffused 5mm tri-color LED with separate red, green and blue LED chips inside! Nice indicator, and fun to color-swirl. 60 degree viewing angle. We like diffused RGB LEDs because they color mix inside instead of appearing as 3 distinct LEDs.

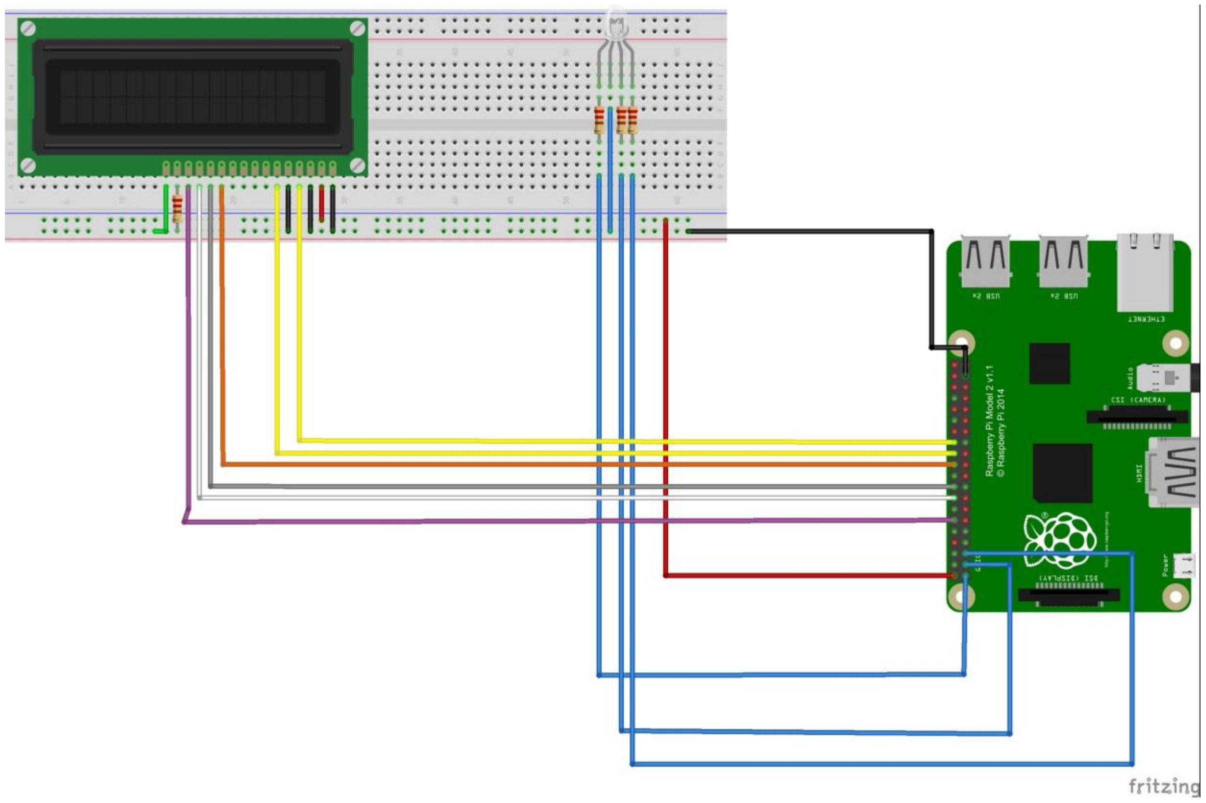
These are Common-Anode type which means you connect one pin to 5V or so and then tie the other three legs to ground through a resistor. We carry and use CA more than CC because multi-LED driver chips (such as the TLC5940/TLC5941) are often designed exclusively for CA and can't be used with Common-Cathode.

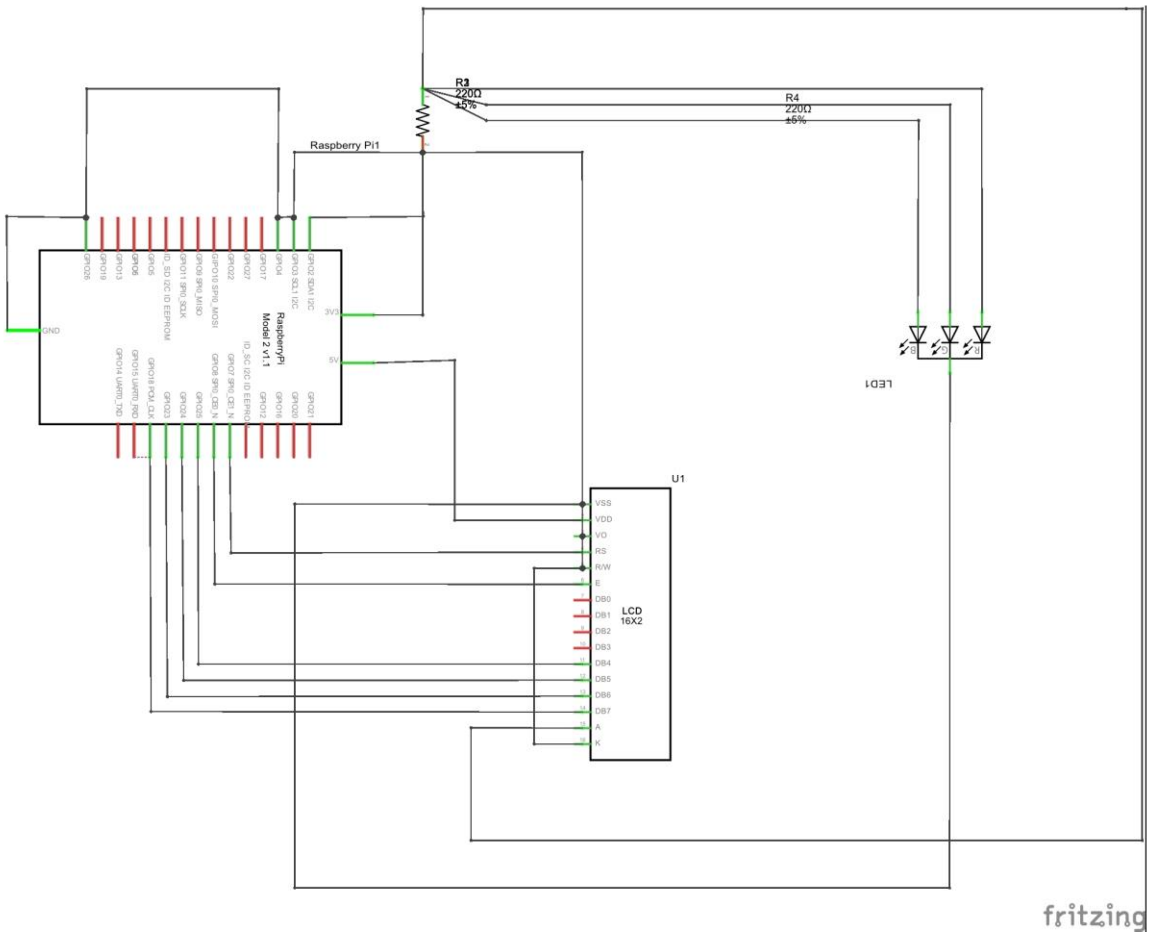
- 5mm diameter
- Red: 630 nm wavelength, Green: 525 nm, Blue: 430 nm
- Red: 2.1-2.5V Forward Voltage, at 20mA current, Green: 3.8-4.5V, Blue: 3.8-4.5V
- Red: 500 mcd typical brightness, Green: 600 mcd, Blue: 300 mcd

Raspberry Pi USB Wi-Fi Dongle

This device is used to connect to Wi-Fi network through USB protocol and onboard drivers. The USB Network Card has a launching function which can launch Wi-Fi signal to your phone under the premise of your computer getting online.

System Schematics





Details of the schematics and design:

Raspberry pi 2 is powered using standard micro USB charger used to charge mobile devices which provide constant 5V output. Typically, the model B uses between 700-1000mA depending on what peripherals are connected; The maximum power the Raspberry Pi can use is 1 Amp. It is running on Raspbian OS which is a deviant of Debain Wheezy Linux Distribution. It has a standard microSD card with 16 GB of storage.

Connections

We did all our connections using standard breadboard.

RGB Led is driven using GPIO (General Purpose Input-Output) 2, GPIO 3, GPIO 4 ports for Red, Green and Blue shades. Since we need to show different colors for different type of notifications, three different ports are chosen. These ports are driven to low (~0V) or high (~ 5V) depending on the software command.

LCD devices usually require 8 data lines to provide data to Bits 0-7. However, the device can be set to a "4 bit" mode which allows you to send data in two chunks (or nibbles) of 4 bits. This is great as it reduces the number of GPIO connections when interfacing with Pi.

Here is how LCD is wired:

LCD Pin	Function	Pi Function	Pi Pin
01	GND	GND	P1-06
02	+5V	+5V	P1-02
03	Contrast	GND	P1-06
04	RS	GPIO7	P1-26
05	RW	GND	P1-06
06	E	GPIO8	P1-24
07	Data 0		
08	Data 1		
09	Data 2		
10	Data 3		
11	Data 4	GPIO25	P1-22

12	Data 5	GPIO24	P1-18
13	Data 6	GPIO23	P1-16
14	Data 7	GPIO18	P1-12
15	+5V via 560ohm		
16	GND		P1-06

In order to control the contrast, we can adjust the voltage presented to Pin 3. This must be between 0 and 5V. Pin 15 provides 5V to the backlight LED. It wasn't clear on this device if this could be connected direct to 5V so I played safe and placed a 560ohm resistor in line with this pin.

Software Design:

Main System Code Details:

Modules Imported

The following modules are imported from standard python. Some modules like `os`, `time`, `urllib2`, `socket`, `struct`, `thread` are available with standard python installation while modules like `facebook`, `gmail`, `RPi.GPIO` have to be installed externally. For LCD the `lcd_module` is written by ourselves and used externally to improve abstraction of the code.

```
import os
import time
import urllib2
import socket
import fcntl
import struct
import facebook
import gmail
from lcd_module import *
import RPi.GPIO as GPIO
import thread
```

LED Control Paradigm

We are making color defined functions to drive the RGB LED to different colors as shown below:

```
def RED():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,0)
def BLUE():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,0)
def GREEN():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,1)

def CYAN():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,1)

def PURPLE():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,1)

def YELLOW():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,0)

def WHITE():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,1)

def OFF():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,0)
```

This is done in a separate thread to provide modularity to the system.

Gmail Notification Access

We defined a separate class to retrieve notifications of new email. We pass authorization parameters to the object of this class to gain access to our account to retrieve email notifications.

```
class MyGmailObject():

    def __init__(self, gmail_username, gmail_password , gmail_access_token):
        #authenticate and login
        gmail.authenticate(gmail_username, gmail_access_token)
        self.mailObject = gmail.login(gmail_username,gmail_password)
```

```
def get_latest_email(self):
        allMessages = self.mailObject.inbox().mail()
        allMessages[len(allMessages)-1].fetch()
        return allMessages[len(allMessages)-1]

    def get_latest_sender(self):
        latestMessage = self.get_latest_email()
        return latestMessage.fr

    def get_latest_subject(self):
        latestMessage = self.get_latest_email()
        return latestMessage.subject

    def get_latest_body(self):
        latestMessage = self.get_latest_email()
        return latestMessage.body

    def get_num_unread_messages(self):
        allMessages = self.mailObject.inbox().mail(unread = True)
        return len(allMessages)

    def close_my_mail(self):
        self.mailObject.logout()
```

Facebook Notification Access

Facebook Notifications are fetched using graph API provided by Facebook. User has to pass an access token from his account and pass on this to the object of graph API. This object is then used to access notifications of that particular user. The following methods are just implementations of this procedure.

```
graph = facebook.GraphAPI(fb_token)
notifications  = graph.get_object("me/notifications")


def getLatestNotificationFrom(notificationsNode):
   try:
    key = 'data'
    if key in notificationsNode:
        latestNotification = notificationsNode[key][0]
        return latestNotification['title']
   except:
    return 'NO NEW NOTIFICATIONS'
```

Our system first scans for internet connectivity to see if it is possible to connect to Facebook and Gmail servers. On successful internet connection it checks for login file in file system. If login credentials are missing or illegal, it waits till correct credentials are put in. On retrieving the correct credentials, it connects to the respective servers and fetch the notifications to display on LCD screen in separate lines.

Open Authorization System

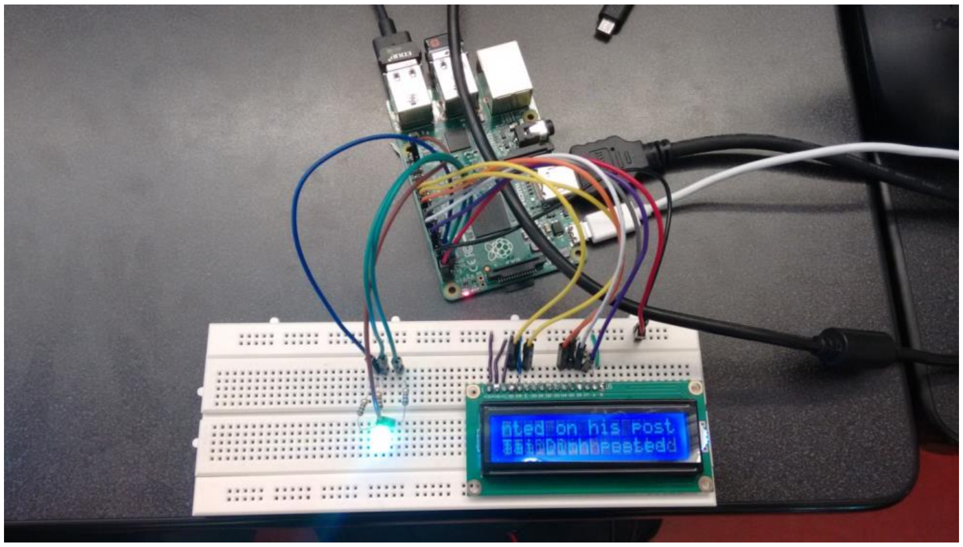
We take security of the user credentials very seriously therefore the user credentials are not stored within the program but in a separate file. This functionality also adds extensibility of users as we can easily modify the login credentials to change user on the system.

oAuthorisation is an executable file attached to our OS to give safe credential input functionality. We can SSH into Raspberry Pi using any normal Computer System on local network and input the requisite parameters. These credentials are stored in encrypted format in hidden file in our file system so that nobody can have access to sensitive data. This functionality also ensures that user has to input the credentials only one time.

<u>Rest of the Details are provided in the code in reference section for any reference.</u>

Conclusion

The interlinking embedded system with social media and personal email has been successfully accomplished in our project. We are successfully able to connect the embedded world with social world which can provide many future applications and provides a stepping stone in field of IOT. Our project demonstrated this functionality using very basic components like raspberry pi 2 and LCD module to display the any latest updates from Facebook, Twitter and Gmail of specific user. This project gave us a valuable opportunity to apply the concepts we learnt in the lectures and labs. This helped us better reflect what we have learnt in this course.



Sources

http://www.raspberrypi-spy.co.uk/2012/07/16x2-lcd-module-control-using-python/

https://developers.google.com/gmail/api/quickstart/python

https://gist.github.com/pdp7/7359910

Appendices

The following is the main code that masters other code files in order to display the notification:

```
import os
import time
import urllib2
import socket
import fcntl
import struct
import facebook
import gmail
from lcd_module import *
import RPi.GPIO as GPIO

import thread



#########################################################

hasNOTIFICATION = False


pin_1 = 2  # GPIO pin 18 controlling LED
pin_2 = 3
pin_3 = 4

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

GPIO.setup(pin_1,GPIO.OUT)
GPIO.setup(pin_2,GPIO.OUT)
GPIO.setup(pin_3,GPIO.OUT)

def RED():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,0)
def BLUE():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,0)
def GREEN():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,1)

def CYAN():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,1)

def PURPLE():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,1)

def YELLOW():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,0)

def WHITE():
    GPIO.output(pin_1,1)
    GPIO.output(pin_2,1)
    GPIO.output(pin_3,1)

def OFF():
    GPIO.output(pin_1,0)
    GPIO.output(pin_2,0)
    GPIO.output(pin_3,0)


def turn_LEDS():
    while True:
        if hasNOTIFICATION:
            RED();
            time.sleep(0.05)
            BLUE();
            time.sleep(0.05)
            GREEN();
            time.sleep(0.05)
            CYAN();
            time.sleep(0.05)
            PURPLE();
            time.sleep(0.05)
            YELLOW();
            time.sleep(0.05)
            WHITE();
            time.sleep(0.05)

########################################################


class MyGmailObject():
    def __init__(self, gmail_username, gmail_password , gmail_access_token):
        #authenticate and login
        gmail.authenticate(gmail_username, gmail_access_token)
        self.mailObject = gmail.login(gmail_username,gmail_password)

    def get_latest_email(self):
        allMessages = self.mailObject.inbox().mail()
        allMessages[len(allMessages)-1].fetch()
        return allMessages[len(allMessages)-1]

    def get_latest_sender(self):
        latestMessage = self.get_latest_email()
        return latestMessage.fr

    def get_latest_subject(self):
        latestMessage = self.get_latest_email()
        return latestMessage.subject

    def get_latest_body(self):
        latestMessage = self.get_latest_email()
        return latestMessage.body

    def get_num_unread_messages(self):
        allMessages = self.mailObject.inbox().mail(unread = True)
        return len(allMessages)

    def close_my_mail(self):
        self.mailObject.logout()


def get_ip_address(ifname):
    s = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
    return socket.inet_ntoa(fcntl.ioctl(
        s.fileno(),
        0x8915,  # SIOCGIFADDR
        struct.pack('256s', ifname[:15])
    )[20:24])

def getLatestNotificationFrom(notificationsNode):
   try:
    key = 'data'
    if key in notificationsNode:
        latestNotification = notificationsNode[key][0]
        return latestNotification['title']
   except:
    return 'NO NEW NOTIFICATIONS'
def lcd_string_print(string,line,length):
   for x in range(0, len(string)-length):
    lcd_string(string[x:x+length],line)
    print string[x:x+length]
    time.sleep(0.45)

def en_decrypt_char(KEY, val):
    if (val > 31 and val < 127):
        return ((val - 32) + (2 * 95) + KEY)%95 + 32

    else:
        return val


def en_decrypt_string(KEY, str_s):
    modified_str = []
    for i in range(len(str_s)):
        c = chr(en_decrypt_char(KEY, ord(str_s[i])))
        modified_str.append(c)
    modified_str = "".join(modified_str)
    return modified_str
s = get_ip_address('wlan0')

authentication = False

displayNotifications = False

while not displayNotifications:
    try:
        urllib2.urlopen("http://www.google.com").close()
    except urllib2.URLError:
        print "Not Connected"
        time.sleep(1)
    else:
        print("Connected")

        while (not authentication):
            OFF()
            hasNOTIFICATION = False

            lcd_string("IP ADDRESS",LCD_LINE_1)
            lcd_string(s,LCD_LINE_2)
            time.sleep(2)
            #os.system('clear')
            lcd_string("Connect Facebook",LCD_LINE_1)
            lcd_string("&Gmail account",LCD_LINE_2)
            time.sleep(2)
            lcd_init()
            lcd_string("SSH to Device",LCD_LINE_1)
            lcd_string("Run oAuthorise",LCD_LINE_2)
            time.sleep(2)
            try:
                if os.stat("/home/pi/.login_notifier").st_size > 0:
                    login_file = open("/home/pi/.login_notifier",'r')

                    fb_token =  login_file.readline()
                    fb_token = fb_token.rstrip('\n')
                    fb_token = en_decrypt_string(-10, fb_token)

                    print fb_token


                    gmail_username = login_file.readline()
                    gmail_username = gmail_username.rstrip('\n')
                    gmail_username = en_decrypt_string(-10, gmail_username)
                    print gmail_username

                    gmail_passwd = login_file.readline()
                    gmail_passwd = gmail_passwd.rstrip('\n')
                    gmail_passwd = en_decrypt_string(-10, gmail_passwd)
                    print gmail_passwd

                    gmail_access_token = login_file.readline()
                    gmail_access_token = gmail_access_token.rstrip('\n')
                    gmail_access_token = en_decrypt_string(-10, gmail_access_token)
                    print gmail_access_token

                    try:
                        graph = facebook.GraphAPI(fb_token)
                        notifications  = graph.get_object("me/notifications")
                        myMail = MyGmailObject(gmail_username, gmail_passwd ,
gmail_access_token)

                        myMail.get_latest_sender()
                        myMail.get_latest_subject()

                        authentication = True
                        displayNotifications = True

                    except:
                        print "Unsuccessful Login attempt"
                        authentication = False
                        displayNotifications = False


                else:
                   print "empty file"
            except OSError:
                print ""
    time.sleep(2)


try:
    thread.start_new_thread(turn_LEDS, ())
except:
    print 'unable to start thread'

lcd_init()

while displayNotifications :

    hasNOTIFICATION = True

    notifications  = graph.get_object("me/notifications")
    s = getLatestNotificationFrom(notifications)
    t = myMail.get_latest_sender()
    lcd_string_print(s,LCD_LINE_1,16)

    myMail = MyGmailObject(gmail_username, gmail_passwd , gmail_access_token)
    u = myMail.get_latest_subject()
    print u
    t = myMail.get_latest_sender()
    lcd_string_print("from: " + t.split('<')[0] +"Subject: " + u + " ",LCD_LINE_2,16)
    #os.system('clear')
```

The following is Authorize.....

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int Key = 10;

int encrypt_decript_char(int KEY, char character_data)
{
	int data;
	if (character_data>31 && character_data<127)
	{
		data = (((int)character_data - 32) + 2 * 95 + KEY) % 95 + 32;
	}
	else
	{
		data = character_data;
	}
	return data;
}

void encode_decode_string(int KEY, char* str)
{
	int i = 0;

	for (i = 0; i < strlen(str); i++)
	{
		str[i] = (char)encrypt_decript_char(KEY, str[i]);
	}
	str[i] = 0;
}


int main()
{
	char fb_token[300];
	char gmail_username[65];
	char gmail_password[100];
	char gmail_access_token[300];



	printf("***************Welcome to Open Authorisation System***************\n");
	printf("Enter your Facebook Login Token for access to your account\n");
	printf("For help look @ http://www.slickremix.com/facebook-60-day-user-access-
token-generator \n");

	//FILE *fp = fopen("/home/aman/.login_notifier", "w");
	FILE *fp = fopen(".login_notifier", "w");

	if (fp < 0)
	{
```

```
            printf("Some problem with System ,Retry Again after some time!!!");
            exit(0);
      }
      printf("Facebook Access Token : ");
      if (fgets(fb_token, 256, stdin)<0)
      {
            printf("Some problem with System ,Retry Again after some time!!!");
            exit(0);
      }
      printf("Enter your Gmail Login Credentials for access to your account\n");
      printf("For help look @ 
https://developers.google.com/gmail/oauth_protocol#constructing_the_oauth_protocol_pa
rameters\n");
      printf("Gmail Username : ");

      if (fgets(gmail_username, 65, stdin)<0)
      {
            printf("Some problem with System ,Retry Again after some time!!!");
            exit(0);
      }

      printf("Gmail Password : ");

      if (fgets(gmail_password, 100, stdin)<0)
      {
            printf("Some problem with System ,Retry Again after some time!!!");
            exit(0);
      }
      printf("Gmail Access Token : ");

      if (fgets(gmail_access_token, 256, stdin)<0)
      {
            printf("Some problem with System ,Retry Again after some time!!!");
            exit(0);
      }
      encode_decode_string(Key, fb_token);
      encode_decode_string(Key, gmail_username);
      encode_decode_string(Key, gmail_password);
      encode_decode_string(Key, gmail_access_token);

      fputs(fb_token, fp);
      fputs(gmail_username, fp);
      fputs(gmail_password, fp);
      fputs(gmail_access_token, fp);


      fclose(fp);



      return 0;
}
```

The following is LCD code:

```
#!/usr/bin/python

# The wiring for the LCD is as follows:
# 1 : GND
# 2 : 5V
# 3 : Contrast (0-5V)*
# 4 : RS (Register Select)
# 5 : R/W (Read Write)       - GROUND THIS PIN
# 6 : Enable or Strobe
# 7 : Data Bit 0             - NOT USED
# 8 : Data Bit 1             - NOT USED
# 9 : Data Bit 2             - NOT USED
# 10: Data Bit 3             - NOT USED
# 11: Data Bit 4
# 12: Data Bit 5
# 13: Data Bit 6
# 14: Data Bit 7
# 15: LCD Backlight +5V**
# 16: LCD Backlight GND

import RPi.GPIO as GPIO
import time
import sys

# Define GPIO to LCD mapping
LCD_RS = 7
LCD_E  = 8
LCD_D4 = 25
LCD_D5 = 24
LCD_D6 = 23
LCD_D7 = 18


# Define some device constants
LCD_WIDTH = 16    # Maximum characters per line
LCD_CHR = True
LCD_CMD = False

LCD_LINE_1 = 0x80 # LCD RAM address for the 1st line
LCD_LINE_2 = 0xC0 # LCD RAM address for the 2nd line

# Timing constants
E_PULSE = 0.0005
E_DELAY = 0.0005

def lcd_init():
  # Initialise display
  lcd_byte(0x33,LCD_CMD) # 110011 Initialise
  lcd_byte(0x32,LCD_CMD) # 110010 Initialise
  lcd_byte(0x06,LCD_CMD) # 000110 Cursor move direction
  lcd_byte(0x0C,LCD_CMD) # 001100 Display On,Cursor Off, Blink Off
  lcd_byte(0x28,LCD_CMD) # 101000 Data length, number of lines, font size
  lcd_byte(0x01,LCD_CMD) # 000001 Clear display
  time.sleep(E_DELAY)

def lcd_toggle_enable():
  # Toggle enable
  time.sleep(E_DELAY)
  GPIO.output(LCD_E, True)
  time.sleep(E_PULSE)
  GPIO.output(LCD_E, False)
  time.sleep(E_DELAY)

def lcd_byte(bits, mode):
  # Send byte to data pins
  # bits = data
  # mode = True  for character
  #        False for command

  GPIO.output(LCD_RS, mode) # RS

  # High bits
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x10==0x10:
    GPIO.output(LCD_D4, True)
  if bits&0x20==0x20:
    GPIO.output(LCD_D5, True)
  if bits&0x40==0x40:
    GPIO.output(LCD_D6, True)
  if bits&0x80==0x80:
    GPIO.output(LCD_D7, True)

  # Toggle 'Enable' pin
  lcd_toggle_enable()

  # Low bits
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x01==0x01:
    GPIO.output(LCD_D4, True)
  if bits&0x02==0x02:
    GPIO.output(LCD_D5, True)
  if bits&0x04==0x04:
    GPIO.output(LCD_D6, True)
  if bits&0x08==0x08:
    GPIO.output(LCD_D7, True)

  # Toggle 'Enable' pin
  lcd_toggle_enable()

def lcd_byte(bits, mode):
  # Send byte to data pins
  # bits = data
  # mode = True  for character
  #        False for command

  GPIO.output(LCD_RS, mode) # RS

  # High bits
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x10==0x10:
    GPIO.output(LCD_D4, True)
  if bits&0x20==0x20:
    GPIO.output(LCD_D5, True)
  if bits&0x40==0x40:
    GPIO.output(LCD_D6, True)
  if bits&0x80==0x80:
    GPIO.output(LCD_D7, True)

  # Toggle 'Enable' pin
  lcd_toggle_enable()

  # Low bits
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x01==0x01:
    GPIO.output(LCD_D4, True)
  if bits&0x02==0x02:
    GPIO.output(LCD_D5, True)
  if bits&0x04==0x04:
    GPIO.output(LCD_D6, True)
  if bits&0x08==0x08:
    GPIO.output(LCD_D7, True)

  # Toggle 'Enable' pin
  lcd_toggle_enable()

def lcd_string(message,line):
  # Send string to display
  message = message.ljust(LCD_WIDTH," ")

  lcd_byte(line, LCD_CMD)

  for i in range(LCD_WIDTH):
    lcd_byte(ord(message[i]),LCD_CHR)
'''
def lcd_string_print(string,line,length):
   for x in range(0, len(string)-length):
    lcd_string(string[x:x+length],line)
    time.sleep(0.5)
'''

GPIO.setwarnings(False)
GPIO.setmode(GPIO.BCM)       # Use BCM GPIO numbers
GPIO.setup(LCD_E, GPIO.OUT)  # E
GPIO.setup(LCD_RS, GPIO.OUT) # RS
GPIO.setup(LCD_D4, GPIO.OUT) # DB4
GPIO.setup(LCD_D5, GPIO.OUT) # DB5
GPIO.setup(LCD_D6, GPIO.OUT) # DB6
GPIO.setup(LCD_D7, GPIO.OUT) # DB7
```

```
# Initialise display
lcd_init()
```