EE2024 PROGRAMMING FOR COMPUTER INTERFACE

Assignment 2 project report

CARE

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Introduction

It is recognized by many people that clean water is a precious resource that can significantly enhance a country's prosperity. However, nowadays clean water free from massive amounts of pollutants became more scare due to the booming population growth in the world and the start of industrial age. While with the advances in sensor devices recently, monitoring process for water resource conditions has became easier. Simple analysis or monitoring of water across vast areas of the water environment can be done by using embedded systems. With the programming of computer interfaces, the core can communicte with the multiple sensors and actuators.

Objectives

With the given scenario in assignment 2, we are required to design a Caring for Aquatic Resources and Environments System (CARE System) . In the CARE Systemwe, we do programming skills to communicate with the sensor devices to monitor the temperature, accelerometer, light in a vast reservoir of clean and resource-rich water.Therefore, turbulence casued naturally or artificailly, sediments and solid wastes pollutants and water temperature affecting the algae growth can all be detected. XBee is used to transmit all the data collected for analysis and reaction taken wielessly . Despite of the basic requirements, we design a monitor mode to predict the growth speed of algae based on relevent biological reserches.

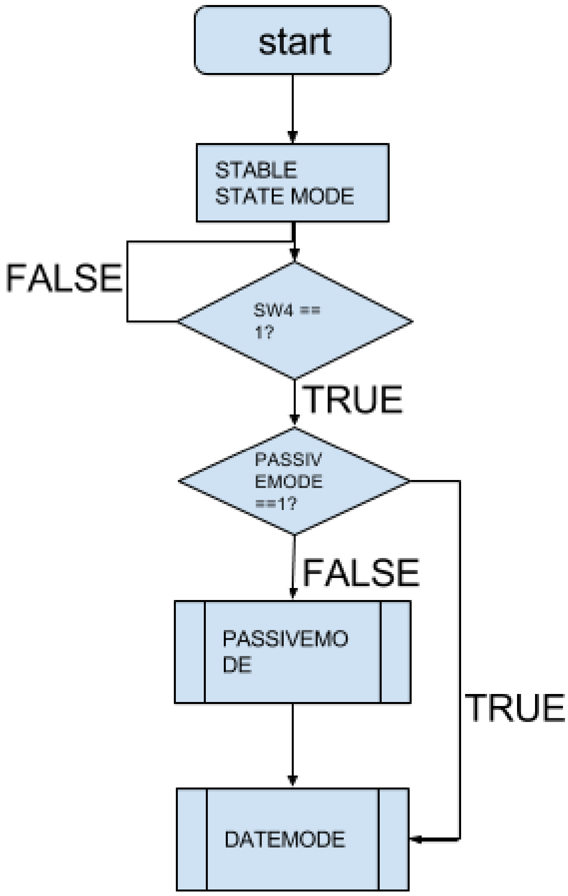
System Design

Flowcharts of the basic system design are provided below. Acoording to the basic requirements, we are supposed to design two modes to achieve the monitoring process. They are **PASSIVE** mode and **Date** mode and certain message is sent to **SAFE** if some conditions are met. SW4 is designed to enter **PASSIVE** mode initially and trigger **Date** mode. In **PASSIVE** mode, the temperature sensor,light sensor, and accelerometer are sampled and specific actions are implemented at specific time for date collection and transmitting. In **Date** mode, human interventions are integrated to deal with abnormal situations. The **Date** mode will last for a short duration before it turns back to **PASSIVE** mode.

The timer used is the build-in timer(Systick/1ms). The design of the basic two modes(**PASSIVE** mode and **Date** mode) is given below in flowcharts.

Main Program Flow Charts

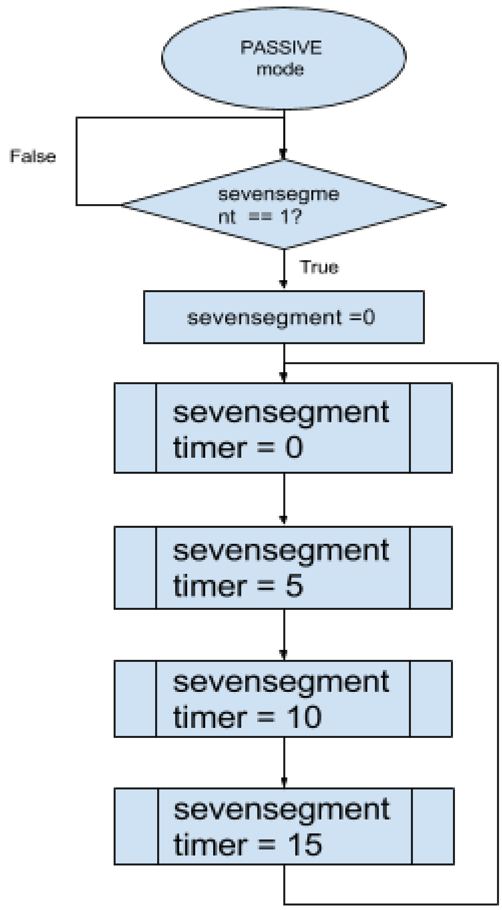
1.Flow chart for basic overview
three modes : stable state, passive mode, date mode



Initial value :
SW4 = 0;
PASSIVEMODE = 0;
SW 4 button at rising edge:
SW4 = 1;
Able to enter passive mode:
PASSIVEMODE = 1;
After entered passive mode:
PASSIVEMODE = 0;
Able to enter date mode:
DATEMODE = 1;

After entered date mode:
DATEMODE = 0;

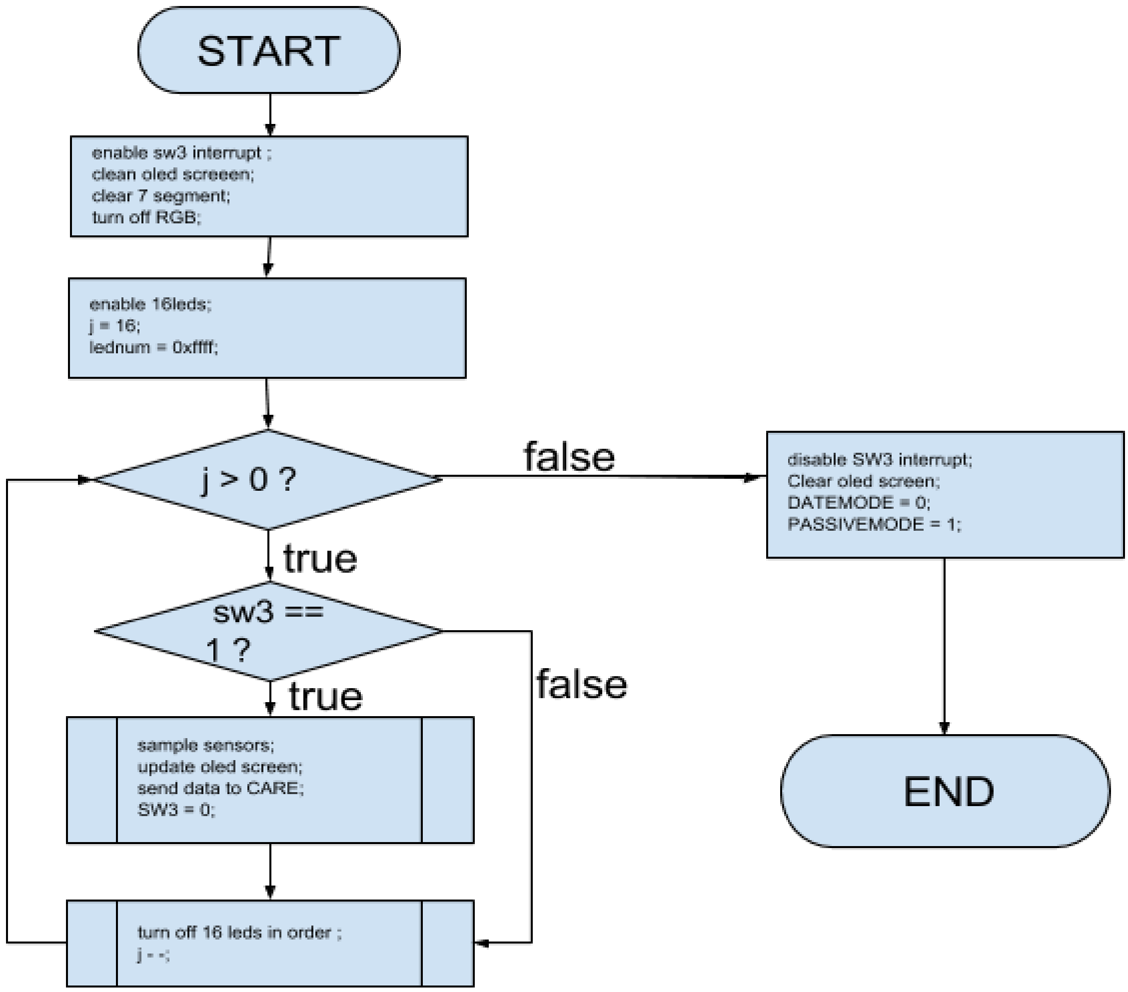
2.Flow chart for Pssive Mode



The code segment is:
The programm will enter passive mode if and only if when sevensegment falg is true. This ensure the programme will run the passivemode 1000ms once.
Once enter the passive mode, the sevensegmenttimer will increase by one every 1000ms second, and certain actions taken place in sequence and the certain conditional falg will be changed.
By checking the centain condition the programm will decide to enter date mode or stay within passive mode. The detail will be explained with the flow charts below.

Initial value :
sevensegment = 0;

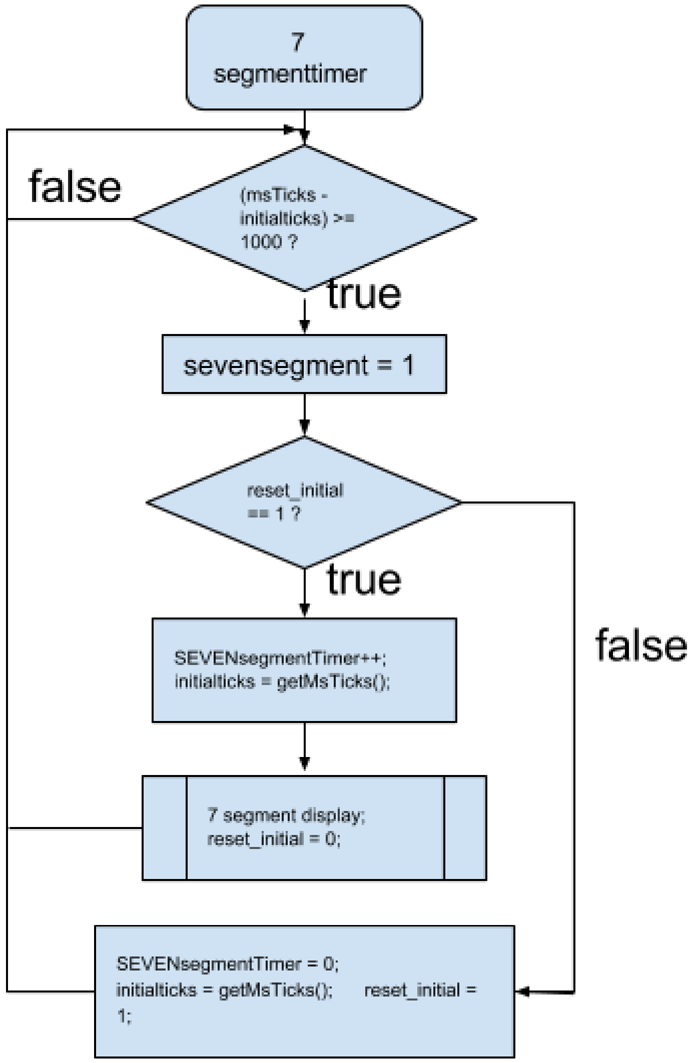
3. Flow chart for Date Mode



The code segment is:
Once the date mode is entered, the oled display, 7 segment display and RGB will be clear. SW3 interrupt is enabled after oled display, 7 aegment and RGB are set to be idle.
The energy indicator 16 led is enabled to light off every 208 ms. We set a counter j = 16 and lednum = oxffff initially. In order to turn off 16 leds one by one evey 208ms. A while loop is constructed here to control the 16 led. The dispaly of 16 leds is achived by left shift lednum and j-- eveytime after one led be turn off immedetly. And before the program turns off next led it will check SW3 flag. which is set to be 1 in EINT3 handler funcion. If SW3 button is pressed, sensor will sample data and update oled as well as send data to CARE through UART. And set SW3 flag back to 0 to make sure multiple SW3 pressed can happen.When j becoms 0,indicating all 16 led off, the while loop is terminated. We then set DATEMODE = 0, PASSIVEMODE = 1 to go back to passive mode. SW3 interrupt is disabled to prevent the interrupt occurs in passive mode in the case that we wrongly press SW3.

Initial value:
j = 16;
lednum = 0xffff;
SW3 = 0;
After turn off current led;
lednum << 1;
j --;
After SW3 be pressed:
SW3 = 1;
After send data to CARE:
SW3 = 0;

4. Flow chart for 7 segment timer



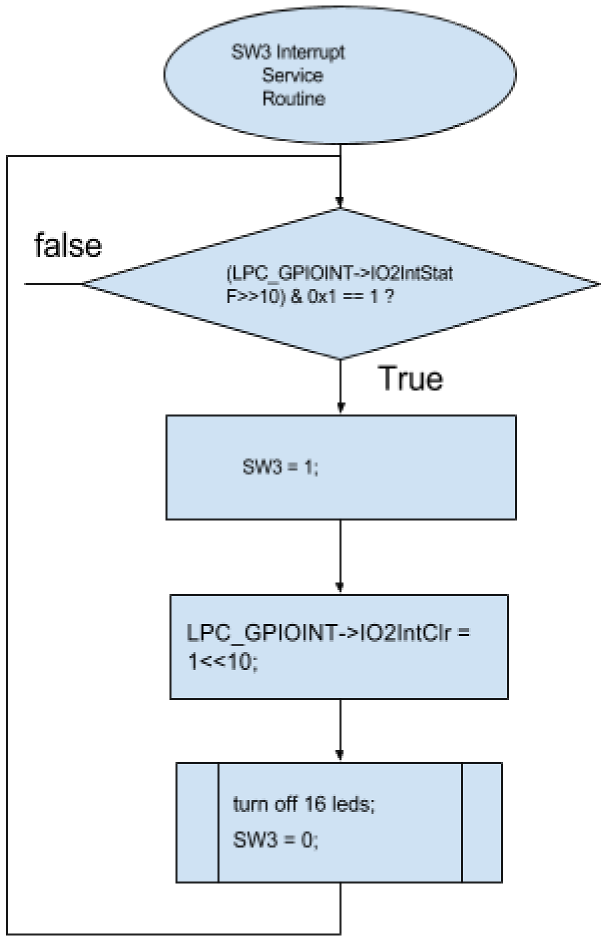
The code segment is:
The 7 segment timer controls the 7 segment display change. Every 1 second passed , we will set the sevensegment flag to be 1, this flag is used to run the swiching of the 7 segment diapaly cases programme every one second and thus we can reduce the flag used.The rest_initial flag is checked to determain if SEVENsegmentTimer will

increase and make initialticks equal to now msTicks so as to change 7 segemnt dispaly every 1

second. If it fails to meet this condition, it still stay in the case 1 programme and waiting to be changed.

Initial value of falgs:
sevensegment = 0;
reset_initial = 1;
After 7 segment shows F:
reset_intial = 0;

5. Flow chart for SW3 Interrupt Routine

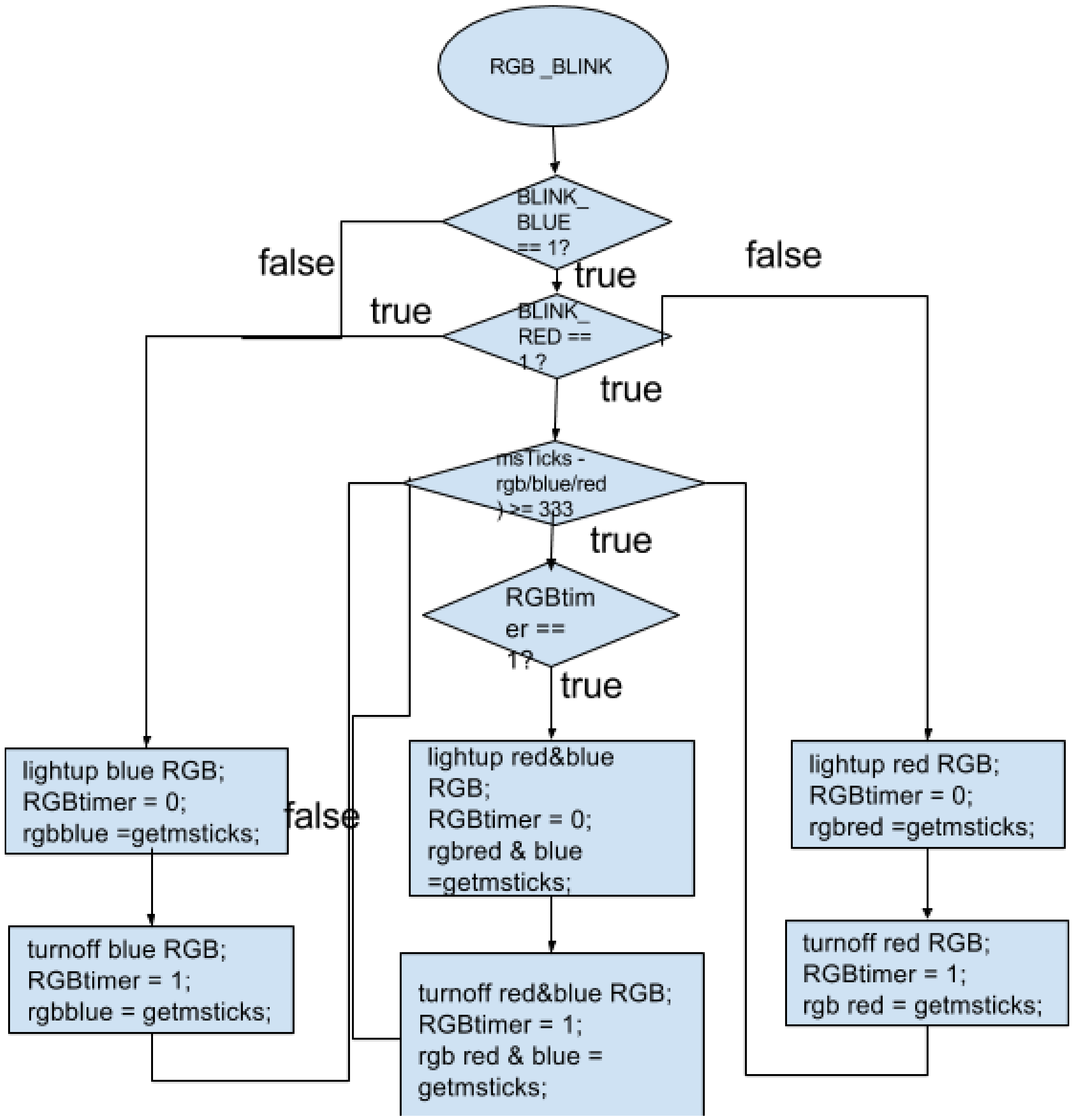


The code segment is:
This SW3 interrupt is only enabled within the date mode and when SW3 is pressed, in EINT3_IRQHandler routine we set the SW3 flag to 1 at the falling edge of SW3 button. Choose falling edge is beacause we want to get the sensor data once we press SW3 button immediately. After sensors sample data and send it to CARE, the SW3 flag will be sent back to 0. Theredore we can press SW3 several times within date mode. The SW3 flag will be used in the date mode to determain if the sampling and sending data should occur. The reason why we want to set flag in handler function instead of

reading sensor and sending data to CARE within the handler is the handler function should as short as possible. The can gurentee the program runs very fast on the hardware.

Initial value of falg:
SW3 = 0;
After SW3 be pressed;
SW3 = 1;
After send data and run the subrotain:
SW3 = 0;

6. Flow chart for RGB RED BLINK



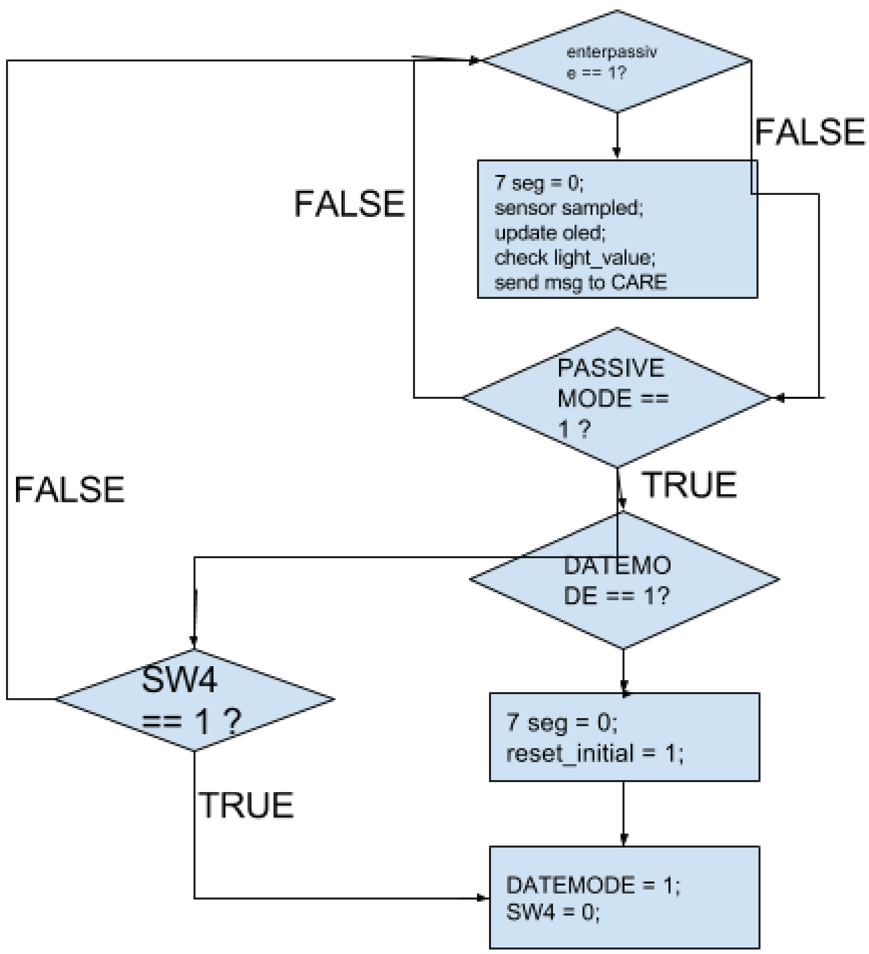
This is the RGB blink part for our program, the red RBG will only blink when BLINK_RED==1 & BLINK_BLUE == 0. And the blue RBG will only blink when BLINK_RED==0 & BLINK_BLUE == 1. This is make sure three combinations of these

two falgs which indicate the certain conditions from light value meeted. And one more important thing is achive red and blue led blink asycronase. We only use one tiem for this situation when BLINK_RED and BLINK_BLUE both ture.
Inirial vales of falgs:

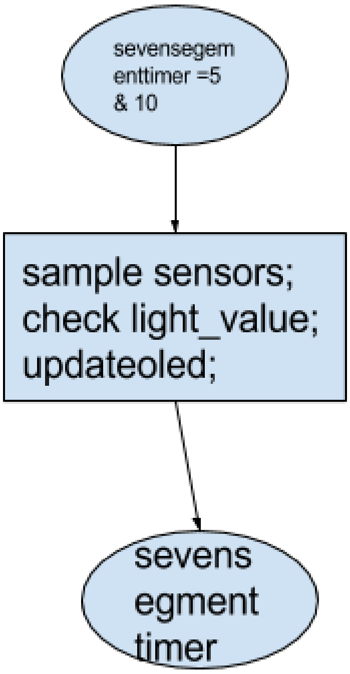
RGBtimer = 0;(Turn off led)
RGBtimer = 1;(Turn on led)
light_value < 50 :
BLINK_RED;
50 <light_value < 1000:
BLINK_BLUE;

7.Flow chart for 7 SEGMENT DISPLAY

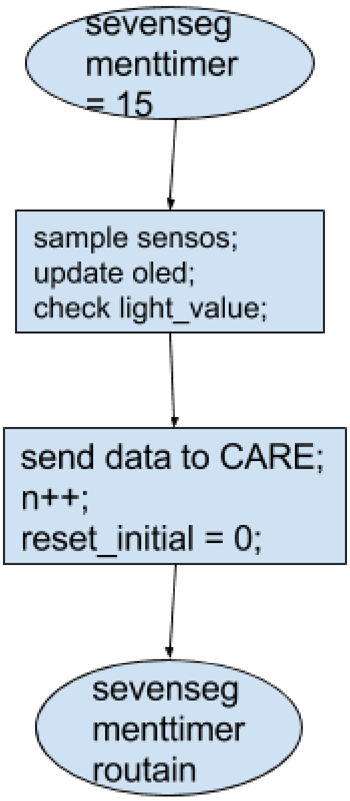
sevensgement timer = 0;



sevensegment timer = 5 & 10;



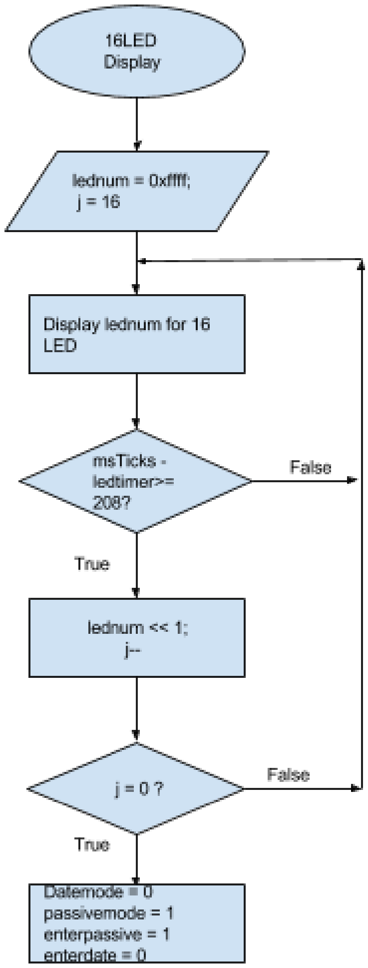
sevensegment timer = 15;



The code segment is:

This flow chart gives details about the subfunction 7 segment display code used in the passive mode. As the 7 segment timer controls, it will update its segment value and correspoding programme every one second. Once the 7 segment case reached 5 and A, sensor will sample value and display on oled, moreover,the programme will check if BLUE_BLINK flag and RED_BLINK flag should be set to 1 according to the light_value.Thses 2 flags will determain if the blink red and blink blue should happen at that time. When the segment status comes to F, it will take all procedures that cases 5 and A have taken. Moreover,sensor value,solid detected and algae detected, according to the BLUE_BLINK and RED_BLINK flag, will be sent to SAFE. The reset_initial flag is set to 0, togather with the SW4 flag status, will determain if continue in passive mode and swich to case 0 or enter date mode.
At case 0 the programm will check go to date mode or stay in passive mode. And at case 15 when the 7 segment dispaly shows F the sensor date will be sent to CARE and the data sent count will be counted.

8. Flow chart for 16 LED energy indicator

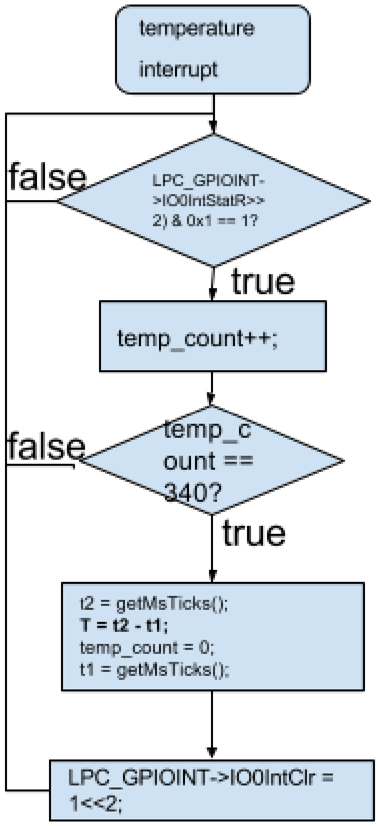


The code segment is:
This is the subfunction used in the date mode. we initially set the variable lednum to 0xffff to light up all 16 led. The variable j is declared to determain when to terminate the while loop we constructed to control the led status movement. Every 208 ms

passed, the lednum status will be shifted 1 bit left direction to turn off one led. Once j is deducted to 1,meaing all 16 led off, break the while loop and set the DATEMODE and ENTERPASSIVE flag to 0, set PASSIVEMODE and ENTERPASSIVE flag to 1. Hence, it goes back to the passive mode.

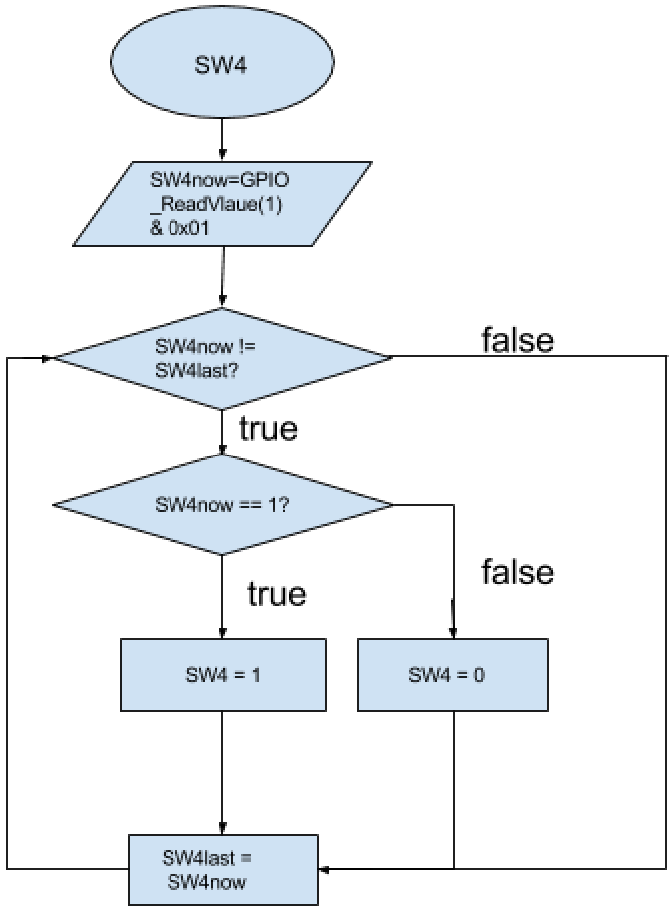
OPTIMISE;

1. Temperature sensor :



The original temperature read in Lib_MUC is a while loop, and the time taken for this while loop is about 0.5s. This time delay will affect the RGB led and also the led dispaly when the sensor be sampled. This part should be optimise in order to achive a accurate timeing control for this assigment. And how we achive this by programming is change the while loop into a interrupt. According to the data sheet, the method to caculate the temperature value is get the number of half cycle and the time taked for these half cycle. Base on the manufacture design 340 cycle is the most accurate value for the frequency used by TS0 = 0 and TS1 = 0.
If we want to use less clock cyle to caculate the temperture value we can change the value of TS0 and TS1 and reset the related jumpers to change the time periord and get less clock cylcles. The time taken will be shorter but the accutacy will be affected. Base on my observation the time taken for TS0 = 0 TS1 = 0 is TS0 =1 TS1 =1 almost the same. But the TS0 = 0 and TS1 = 0 provide a more accurate result. And that's why we decise to use TS0 = 0 TS1 = 0. The temperature interrupy will only take time and rising edge and it's very fast by comparing with the lib function be provied for us.

2. Flow chart for SW4 pressed



The code segment is:

This is very important for check the SW4 state only at rising edge. Bacause the external interrupt is only avaliable for port 0 and port 2. We cannot catch the rising edge of SW4 as the rising edge of SW3 by external interrupt. The way I achive the same result is by chacking the SW4 state. The state will only chage when at rasing edge or rising edge. And the one we wanna catch is rising edge, the difference for rising edge and falling edge is the SW4now state is 1(after release SW4) for rasing edge. And the SW4 will be set to 1 if and only if at rising edge. And this is very important to make sure when we press SW4 for a long time nothing will during this period, and the programming will not jump to date instead of go to passive.

The main programme **PASSIVE** mode and **DATE** mode are implemented according to the flow charts showed above, all the peripherals and subfunctions contained in these two modes all also running according to the related flow charts logics.

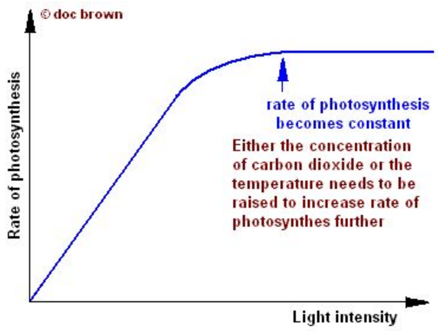
Initially, the programme will check the SW4 status constantly and stay in the while loop unless the SW4 is pressed to enter the PASSIVE mode.

Once the SW4 is pressed, the PASSIVE mode is activated, the programme will follow the given logic from the flow charts to run certain steps one by one.

Enhancement:
FOR THIS PART WE DESIGNED IT ALREADY BUT DON’T HAVE TIME TO ACHIEVE THE WHOLE DESIGN. BUT WE STILL WANT TO SHOW OUR EFFERT ON THIS REPORT.

In our enhancement, an additional MONITOR mode is designed, which is triggered by SW2. In **MONITOR** mode, the algae growth speed and predicted amount will be sent to SAFE after some collected data evaluation. To make sure the liability of the predicted value, we only enter the MONITOR mode when sufficient data has been collected, namely, after the first complete round of PASSIVE mode.

Monitor Mode
Aim: Prediction and monitor of algae growth
Algorithm:
There are 2 main factors affect the growth speed of algae
1.Algae as plants will undergo photosynthesis to compound organics for its growth and thus light intensity is a factor to affect its growth speed.



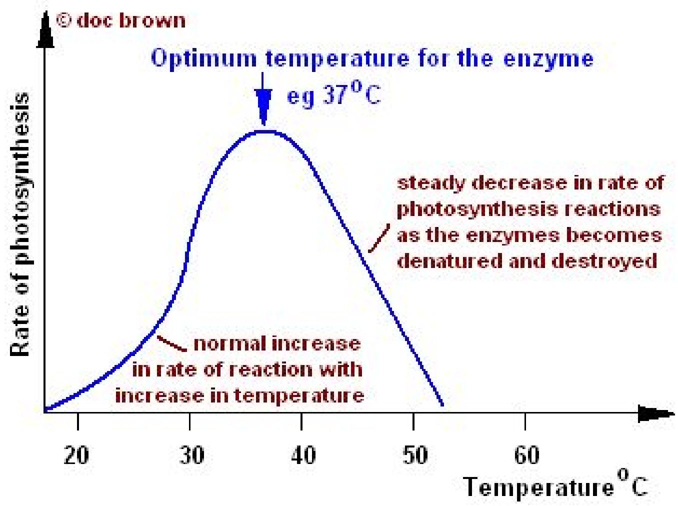
Source:http://www.docbrown.info/ebiology/photosynthesis.htm

V is proportional to Lux before the satisfied point (6000lux)

So 0 to 4000 lux can be approx as proportional V = k1*L

2. The activity of enzyme in algae affect the metabolism speed which also influence the organics produced speed

Temperature is also a factor affecting the growth speed.



Source:http://www.docbrown.info/ebiology/photosynthesis.htm

From range 25 to 30, the model can be approx as V = k2*K(square)

Assumption:

Temperature: 25 ~ 30

Light intensity 0 ~ 4000 lux

The model:

$V = k1*I + k2*T(square)$

V is the growth rate

Predicted amount = A = Original amount + V * Days

Maximum growth rate was found 1.73 d^{-1} for *Selenastrum minutum* at 30 °C and 6000 lux

Minimum growth rate (0.10 d^{-1}) was reported for *Botryococcus braunii* KMITL 2 strain at temperature 25 °C

This two conditions help us find the coefficients k1 and k2

Mode Design

when SW2 pressed, entering monitor mode.

7 sge run from 1 to 9

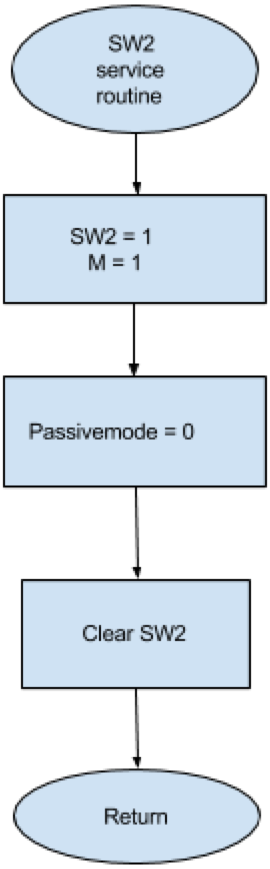
1: algae growth speed is calculated by the model mentioned above
and send to uart and also show on the oled

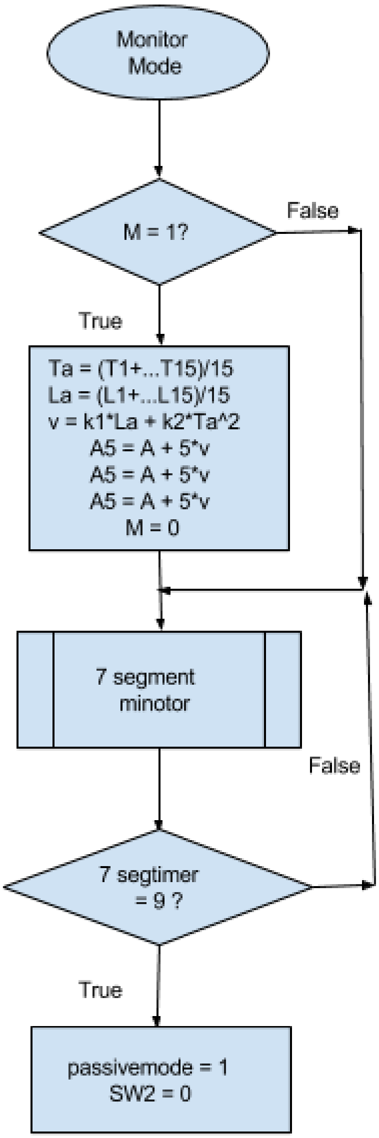
4: current algae amount is sent to uart and shown on oled.

7: predicted algae amount(5 days, 10 days, 30days) are sent to uart and shown on oled.

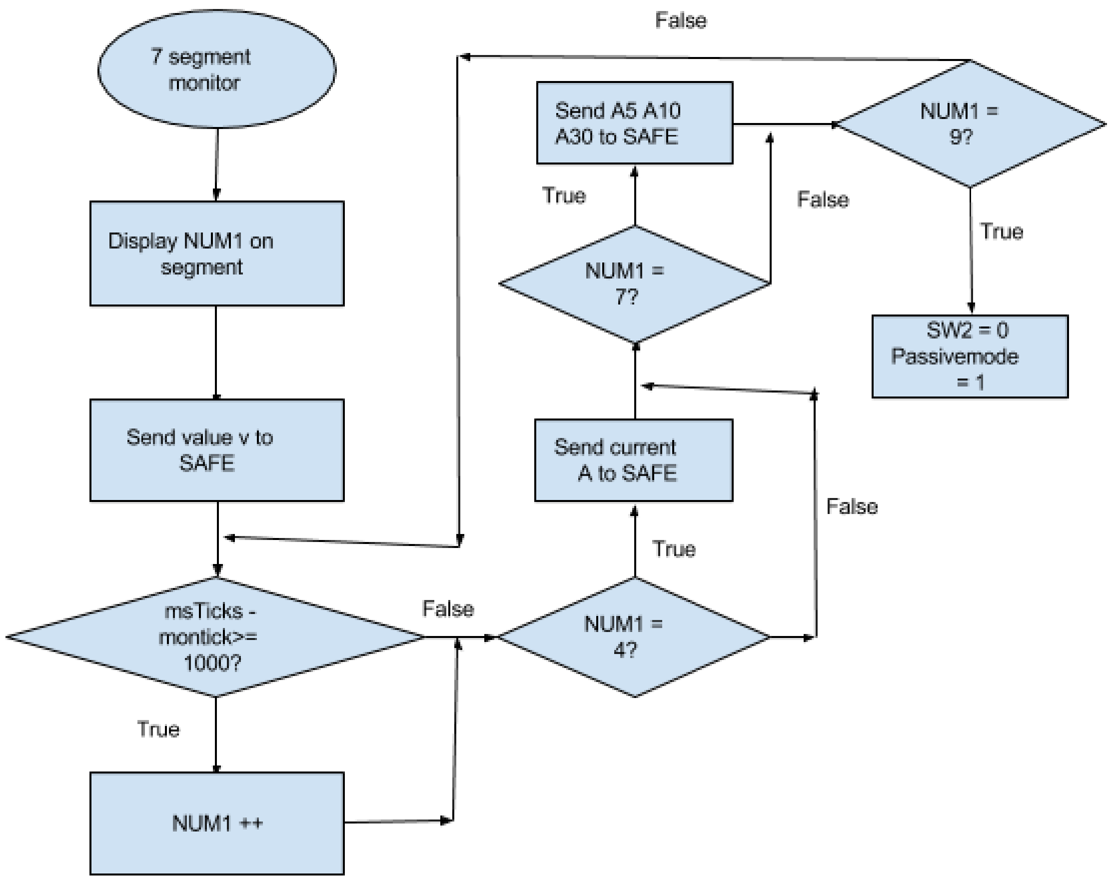
After 9 : back to passive mode.

10. Flow charts for SW2 interrupt and monitor mode


SW2
service
routine
SW2 = 1
M = 1
Passivemode = 0
Clear SW2
Return


Monitor
Mode
M = 1?
False
True
Ta = (T1+...T15)/15
La = (L1+...L15)/15
v = k1*La + k2*Ta^2
A5 = A + 5*v
A5 = A + 5*v
A5 = A + 5*v
M = 0
7 segment
minotor
False
7 segtimer
= 9 ?
True
passivemode = 1
SW2 = 0

11.Flow charts for monitor mode 7 segment



Conclusion:

In this EE2024 assignment 2 project, we have applied the theories and progrmming skills learnt in the lectures to get familiar with both the software environments and the hardware devives.The exploring process is very struggling but interesting. We struggle to fullfill each requirement one by one and continuously encounter problems and try our best to solve them. The interesting part is that we will have the sense of achievement when we could solve problems with the knowledge we learned. Learing is still in progress, we can feel that we indeed aqcuire useful knowledge in this module. Thanks to the teaching team of EE2024, we indeed have a nice journey with EE2024.