

CG2271 Real Time Operating Systems

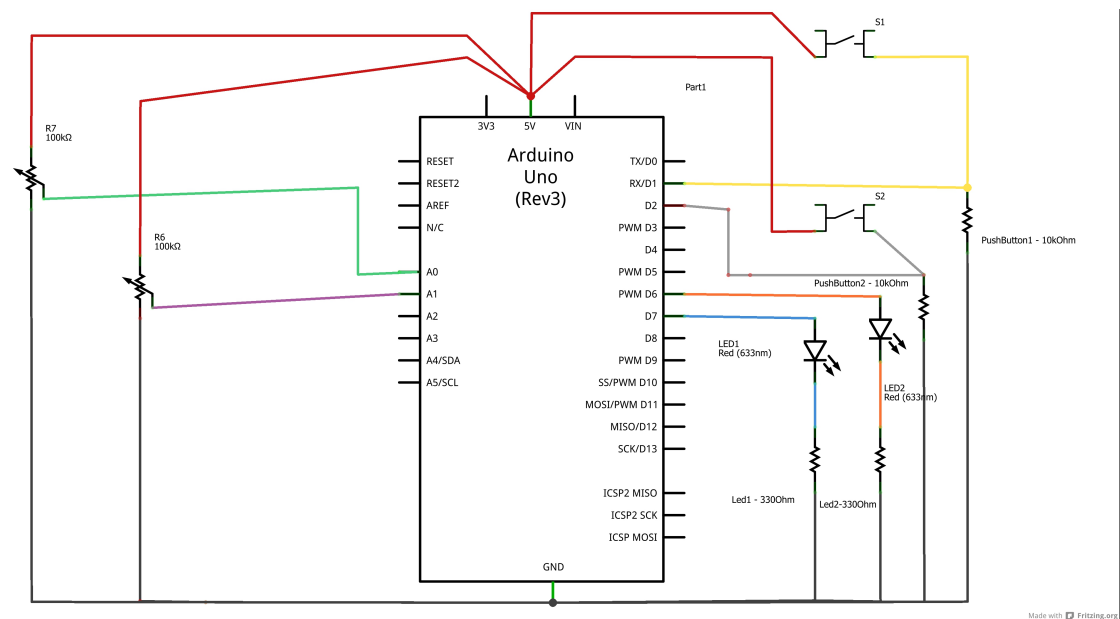
Lab 2 – Real Time Architectures

Answer Book

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Question 1 (3 marks)

Paste a sketch of your circuit below.



Question 2 (3 marks)

The PWM generator at PIN 6 of the Arduino board can only process values in the range of 0 - 255. However, the input supplied is in the range of 0 - 1023. Hence, the pin takes modulo of the given values, resetting the brightness to minimum once the value crosses 255. Therefore, the brightness of the led fluctuates from high to low to high instead of a linear change.

Question 3 (5 marks)

```
#define FROM_MAX_PTM 1023.0 //max value obtained from potentiometer
#define FROM_MIN_PTM 0.0 //min value obtained from potentiometer
#define TO_MAX_PTM 255.0 //max remapped value of potentiometer
#define TO_MIN_PTM 0.0 //min remapped value of potentiometer
```

```
int remap(int val)
{
    return (int) map(val, FROM_MIN_PTM, FROM_MAX_PTM, TO_MIN_PTM,
TO_MAX_PTM);
}
```

This function maps the original range, from 0-1023 to the new range, 0-255. Hence, in the brightness of the led changes linearly as the range of the input given to the led is accepted by the Arduino board.

Question 4 (3 marks)

Minimum value observed: 0

Maximum value observed: 1002

Question 5 (5 marks)

```
#define FROM_MAX_TOUCH 1002.0 //max value obtained from touch sensor
#define FROM_MIN_TOUCH 0.0 //min value obtained from touch sensor
#define TO_MAX_TOUCH 500 //max remapped value of touch sensor
#define TO_MIN_TOUCH 125 //min remapped value of touch sensor
int remapTouch(int val)
{
    return (int) map(val, FROM_MIN_TOUCH, FROM_MAX_TOUCH, TO_MIN_TOUCH,
TO_MAX_TOUCH);
}
```

Question 6 (3 marks)

```
#include <avr/io.h>
#include <Arduino.h>
#define polledPin 2
#define analogOut 6
#define analogChannel 0

#define FROM_MAX_TOUCH 1002.0 //max value obtained from touch sensor
#define FROM_MIN_TOUCH 0.0 //min value obtained from touch sensor
#define TO_MAX_TOUCH 500 //max remapped value of touch sensor
#define TO_MIN_TOUCH 125 //min remapped value of touch sensor

#define FROM_MAX_PTM 1023.0 //max value obtained from potentiometer
#define FROM_MIN_PTM 0.0 //min value obtained from potentiometer
#define TO_MAX_PTM 255.0 //max remapped value of potentiometer
#define TO_MIN_PTM 0.0 //min remapped value of potentiometer

void setup()
{
    pinMode(2, INPUT);
    pinMode(7, OUTPUT);
    Serial.begin(9600);
}

void flashPin7(int delayVal)
```

```

{
    digitalWrite(7, HIGH);
    delay(delayVal);
    digitalWrite(7, LOW);
    delay(delayVal);
}

int remap(int val)
{
    return (int) map(val, FROM_MIN_PTM, FROM_MAX_PTM, TO_MIN_PTM,
TO_MAX_PTM);
}

int remapTouch(int val)
{
    return (int) map(val, FROM_MIN_TOUCH, FROM_MAX_TOUCH, TO_MIN_TOUCH,
TO_MAX_TOUCH);
}

void loop()
{
    int val=analogRead(0);
    int analogVal = remap(val);

    int touch=analogRead(1);
    int analogTouch = remapTouch(touch);

    Serial.print(analogVal);
    Serial.print(" ");
    Serial.print(analogTouch);
    Serial.println();

    analogWrite(analogOut, analogVal);
    delay(500);
    flashPin7(analogTouch);
}

```

The variable “touch” first takes the reading from analog pin A1 (of touch sensor). This value is then remapped by remapTouch to the range 125-500. This in turn is passed to flashPin7 which uses it as a delay between each blink. Hence, when the touch sensor senses lower value, the delay between blinks is smaller, hence the LED at pin 7 blinks more rapidly.

Question 7 (6 marks)

```

#include <avr/io.h>
#include <Arduino.h>
#define polledPin 2
#define analogOut 6
#define analogChannel 0

#define FROM_MAX_TOUCH 1002.0 //max value obtained from touch sensor
#define FROM_MIN_TOUCH 0.0 //min value obtained from touch sensor
#define TO_MAX_TOUCH 500 //max remapped value of touch sensor
#define TO_MIN_TOUCH 125 //min remapped value of touch sensor

#define FROM_MAX_PTM 1023.0 //max value obtained from potentiometer
#define FROM_MIN_PTM 0.0 //min value obtained from potentiometer
#define TO_MAX_PTM 255.0 //max remapped value of potentiometer

```

```

#define TO_MIN_PTM 0.0 //min remapped value of potentiometer

#define INPUT1BUTTON 2 //connected to pin 2, first push button
#define INPUT2BUTTON 3 //connected to pin 3, second push button

int val = 0.0;
int analogVal = 0.0;
int touch = 0.0;
int analogTouch = 0.0;

void setup()
{
    pinMode(2, INPUT);
    pinMode(3, INPUT);
    pinMode(7, OUTPUT);
    Serial.begin(9600);
}

void flashPin7(int delayVal)
{
    digitalWrite(7, HIGH);
    delay(delayVal);
    digitalWrite(7, LOW);
    delay(delayVal);
}

int remap(int val)
{
    return (int) map(val, FROM_MIN_PTM, FROM_MAX_PTM, TO_MIN_PTM,
TO_MAX_PTM);
}

int remapTouch(int val)
{
    return (int) map(val, FROM_MIN_TOUCH, FROM_MAX_TOUCH, TO_MIN_TOUCH,
TO_MAX_TOUCH);
}

void loop()
{
    analogWrite(analogOut, analogVal);
    flashPin7(analogTouch);

    if (digitalRead(INPUT1BUTTON))
    {
        val = analogRead(0);
        analogVal = remap(val);
    }

    if (digitalRead(INPUT2BUTTON))
    {
        touch = analogRead(1);
        analogTouch = remapTouch(touch);
    }
}

int main(void)
{
    init();
    setup();
    while(1)
    {

```

```
        loop();  
        if(serialEventRun)  
            serialEventRun();  
    }  
    return 0;  
}
```

When the first push button is pressed, digitalRead will read from input pin 2, then the first “If” statement is executed: takes reading from the potentiometer at pin A0, remaps to the correct range and then outputs to the LED at pin 6. Similarly, when the second push button is pressed, digitalRead will read from input pin 3, then the second “If” is executed: takes reading from touch sensor at pin A1, remaps to the correct range, and then makes the rate of blinking of the LED at pin 7 change accordingly.

Similar to round robin which loops infinitely and processes data every time there is reading from sensors, the circuit here will loop and processes data (changes LED blinking rate and brightness) every time there is a button press.

Question 8 (12 marks)

```
#include <avr/io.h>
#include <Arduino.h>
#define polledPin 2
#define analogOut 6
#define analogChannel 0

#define FROM_MAX_TOUCH 1002.0 //max value obtained from touch sensor
#define FROM_MIN_TOUCH 0.0 //min value obtained from touch sensor
#define TO_MAX_TOUCH 500 //max remapped value of touch sensor
#define TO_MIN_TOUCH 125 //min remapped value of touch sensor

#define FROM_MAX_PTM 1023.0 //max value obtained from potentiometer
#define FROM_MIN_PTM 0.0 //min value obtained from potentiometer
#define TO_MAX_PTM 255.0 //max remapped value of potentiometer
#define TO_MIN_PTM 0.0 //min remapped value of potentiometer

#define INPUT1BUTTON 0 //connected to pin 2, first push button
#define INPUT2BUTTON 1 //connected to pin 3, second push button

int val = 0.0;
int analogVal = 0.0;
int touch = 0.0;
int analogTouch = 0.0;

int remap(int val)
{
    return (int) map(val, FROM_MIN_PTM, FROM_MAX_PTM, TO_MIN_PTM,
TO_MAX_PTM);
}

int remapTouch(int val)
{
    return (int) map(val, FROM_MIN_TOUCH, FROM_MAX_TOUCH, TO_MIN_TOUCH,
TO_MAX_TOUCH);
}

void potentiometerISR()
{
    val = analogRead(0);
    analogVal = remap(val);
}

void touchSensorISR()
{
    touch=analogRead(1);
    analogTouch = remapTouch(touch);
}

void setup()
{
    pinMode(7, OUTPUT);

    attachInterrupt(INPUT1BUTTON, potentiometerISR, FALLING);
    attachInterrupt(INPUT2BUTTON, touchSensorISR, FALLING);
    Serial.begin(9600);
}

void flashPin7(int delayVal)
{
    digitalWrite(7, HIGH);
```

```

        delay(delayVal);
        digitalWrite(7, LOW);
        delay(delayVal);
    }

    void loop()
    {
        analogWrite(analogOut, analogVal);
        flashPin7(analogTouch);
    }

    int main(void)
    {
        init();
        setup();
        while(1)
        {
            loop();
            if(serialEventRun)
                serialEventRun();
        }
        return 0;
    }

```

When the corresponding button is pressed (the pin is “FALLING”), the respective ISR is called, then the reading is read from the sensors and the output changes accordingly.