CSCI130: Mobile Robotic Devices Embedded Systems
Lab2: Digital I/O

Lab Overview:

This lab is an exercise in which participants use the Romeo Microcontroller kit and the IO Trainer Kit to implement an embedded system that can perform various digital input and output functions.

Notes on IO Trainer Board:

Part of the learning objective of this lab is to gain the understanding of how to connection a microcontroller's digital input and output port to various components. The components used DIP switch (SW1), the momentary switches (S1-S4) and the LED bar on the IO Trainer Board. To understand how these components are connected, examine schematic. The schematic of the I/O Trainer Board is named "IOTrainerV11Sch.png" and can be found amongst the Lab 2 files.

Before getting started, here are some notes and hints:

- The ground of the IO Trainer Board and Romeo Microcontroller board must be connected
- If an output pin of the Romeo Board is set high and is connected to one of the JP3 jumper, the corresponding LED on the bar will light up
- All of the switches (4 DIP switches and 4 momentary switches) have one side connected to ground and the other connected to JP2.
- **DO NOT** use pins PD0 and PD1 (D0 and D1 labeled on Romeo board). These pins are normally used for serial communication and are in that mode by default. There is a way to disable them to be used for normal pins operation but serial communication is not covered until later modules. For this lab, do not use them.

Lab 2A (3 Marks)

i. Connect 8 LEDs on the IO Trainer Board to 8 pins on the Romeo Board.

ii. Write a C program that uses the 8 LEDs as a binary display. The program will display the binary representation of the number 0 to 255 in sequence at 1 Hz interval. When the number reaches 255, it will loop back to 0.

iii. At the beginning program, create a comment section that illustrates the connection from the Atmega328p microcontroller to the component on the IO Trainer Board. For example

```
/* Connection Diagram
Atmega328p      Romeo board     IO Board Jumper       Component
PD0 ->          D0 ->           JP3_1 ->              D1A
…
*/
```

iv. Name the file lab2a.c

Lab 2B (6 Marks)

i. Connect 8 LEDs on the IO Trainer Board to 8 pins on the Romeo Board.

ii. Connect 2 of the 4 momentary switches (S1-S4) on the IO Trainer Board to 2 pins on the Rome Board

iii. Write a C program that uses the 8 LEDs as a binary display and 2 momentary switches as input. The program should keep a count. When one of the two switches is pressed then released, the

count should increase by 1 and if the other is pressed then released, the count should decrease by 1. The count should go from 0 to 255 and loop back to 0. The program should display the binary representation of the count using the 8 LEDs.

iv. At the beginning program, create a comment section that illustrates the connection from the Atmega328p microcontroller to the component on the IO Trainer Board. The connections should include the LEDs and switches. For example

```
/* Connection Diagram
Atmega328p      Romeo board     IO Board Jumper       Component
PD0 ->          D0 ->           JP2_5 ->              S1
…
*/
```

v. Name the file lab2b.c

Lab 2C (6 Marks)

i. Connect 8 LEDs on the IO Trainer Board to 8 pins on the Romeo Board.

ii. Connect the 3 DIP switches (SW1_1-SW1_4) on the IO Trainer Board to 3 pins on the Romeo Board

iii. Write a C program that uses the 8 LEDs as a number display and 3 DIP switches as input. The program should read in the state of the 3 DIP switches as a binary number where SW1_1 is the most significant bit and SW1_3 is the least significant bit.

For example if SW1_1 = ON, SW1_2 = ON, SW1_3 = OFF then the number interpreted by the program should be 0b00000110 = 6

In this program the 8 LEDs will not be display the binary representation of the number read from the DIP switches. Instead the number read in from the DIP switches should be represented by the number of LEDs that is lit up. For example if the DIP switches is set to 0b000000011, 3 LEDs should be lit up.

iv. At the beginning program, create a comment section that illustrates the connection from the Atmega328p microcontroller to the component on the IO Trainer Board. The connections should include the LEDs and switches. For example

```
/* Connection Diagram
Atmega328p      Romeo board     IO Board Jumper       Component
PD0 ->          D0 ->           JP2_1 ->              SW1_1
…
*/
```

v. Name the file lab2c.c

Total number of marks: 15

Submission

Participant must submit a video demonstrating that the system works as described in 2A, 2B, and 2C. The video can be uploaded to the D2L or uploaded to Youtube (include link). Additionally, 3 files should be submitted through D2L: lab2a.c, lab2b.c, lab2c.c.