**EE260**: **The Final project & exam**

**Total: 20 points**

**Please demo project before May 4, 2020.**

In this project you shall use the FRDM KL25z microcontroller board to design a system that shall use various peripherals in the starter kit

* to control the position of a Servo using PWM using the hardware and software
* to control the speed of a dc motor using the hardware and software
* to put the servo in a scan mode so it move from left to right and back
* to control the position of the servo from a PC terminal
* to play a siren on the passive buzzer speaker
* to display messages and data on the LCD panel and on a PC serial terminal.

Other details are mentioned below.

**PWM signal generation:**

For a Servo, the PWM period is fixed at 20 ms, and the pulse width is 1.5 ms the motor is in the neutral position. The pulse width is varied from 0.553 ms to 2.52 ms to move the shaft by ±90 degrees. Thus, the duty cycle of the PWM varies between about 2.7 to 12.6 percent.

**Analog to Digital (A/D) conversion**: The FRDM KL25Z board has 14 ADC0 converter channels of the Cortex-M0+ chip. Refer to the pin connections in the Textbook.

The Starter kits have

* a couple of potentiometers (Trimmer Pot)
* a couple of light sensors (photo-resistor) and

The goal is to use the two analog voltages to control the position of the servo and the speed of the dc motor. The inputs are from

* a potentiometer that varies between 0-3.3 V
* a voltage divider made with two photo-resistors that uses a 3.3 V source.

**Ultrasonic sensor:**  The system shall use an ultrasonic sensor shall be used as a protection mechanism to warn the system operator when someone tries to touch the system by turning on LED lights and playing a siren.

**Matrix Keyboard:** The system shall use the matrix keyboard to select from five operating modes. The user shall select the operating modes by first pressing the # key on the keypad using hardware interrupt followed by one number key (1 through 5) on the keypad. The numbers pressed shall choose the sensor inputs, put the servo in the scan mode and a manual position or speed control mode.

The key press values for the mode selections are summarized below:

1. Sensor sources - Potentiometer & Phototransistor: controls the Servo
2. Sensor source - Potentiometer and ultrasonic sensor controls the DC motor
3. Scan mode or servo (-90 to 90 degrees with user configurable speed from the PC)
4. Manual position control of the servo from the PC serial terminal
5. Manual speed control of the DC motor from the PC serial terminal

The 5 modes are as follows:

**Mode 1**: The A/D values from these two sources shall control the position of the servo in the following manner. The servo shall be primarily controlled by potentiometer unless the mid-point value of the photo-resistor voltage resistor is within the range of 1.65±0.35 V. At the point, the potentiometer shall not have any control on the servo.

**Mode 2:** The DC motor shall be controlled by the potentiometer. DC motor shall use the 5 V power supply with an h-bridge chip (L293D). The PWM signal amplitude shall be limited to 3.3 V. The ultrasonic sensor shall alert the user with a blue led that a moving object is within 2 feet from the dc motor. If the object moves closer than 1 foot, led shall turn red and the DC motor shall stop until the object moves out of the range. The ultrasonic sensor shall alert the user with a siren (use the buzzer) whose frequency shall vary from 500 Hz to 3 KHz as the object moves between 2 feet and one foot of distance from the DC motor. For demonstration purpose, the system shall have ultrasonic sensor. So orient the sensor in one direction to show the functionality.

**Mode 3**: The servo shall repeatedly scan from -90 to +90 degrees and back. The user should be able to select several scan speeds from the PC using putty.

**Mode 4:** The user should be able to control the angular position of the servo from the PC. The angular resolution should be less than 0.1 degree.

**Mode 5:** The use should be able to control the speed of the motor. However, the ultrasonic sensor shall be used as in Mode 2.

**LCD Display:** The name of operating mode should be displayed on the first line of the on board LCD. You are free to choose other useful information on the second line.

**Serial Communication Interface (UART)**: The message and the data displayed on the LCD panel should also be displayed on a serial terminal (e.g. Putty) on a PC connected to the FRDM KL25Z board. The serial terminal can be used to send commands to control the scan rate of the servo in the automatic scan mode and also set the position of the servo from -90 to +90 degrees with 0.1 degree resolution.

**Design Constraints:** For full points, the design must not use any of the software-based delay functions or polling.

**Rules of Ethics:**

* Rule for this exam is that you can only work with your partners. If there are evidences of collaboration between groups, everyone in the groups shall get a zero in the final.
* If you use any help from the net, you should cite the source explicitly.
* Teams must not cooperate in writing the report.

**Grade Distribution:**

* The project has 12 points.
* The group report has 4 points
* The oral exam has 4 points

The project shall be demonstrated using Zoom. Prof. Khondker shall provide a sign-up schedule for each team to demo the project. The team shall upload a report (**before demo**) with details of the design so one can understand the design process.