**EE360**: **The Final project (20 points)**

In this project you will use the HCS12 microcontroller

* to control the position of a Servo using PWM and one of two on-board sensors.
* 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 speaker using OC5 Timer port.
* to display messages and data on the LCD panel and on a PC serial terminal.

The controller code should be written in C. Other details are mentioned below.

**PWM signal generation:** A Servo is a small device that incorporates a three wire DC motor, a gear train, a potentiometer, an integrated circuit, and an output shaft bearing. For more details please visit the following sites:

<http://www.servocity.com/html/what_is_a_servo_.html>

<http://www.servocity.com/html/hs-645mg_ultra_torque.html>

The shaft of the servo can be positioned to specific angular positions by sending a pulse width modulated (PWM) signal. As long as the PWM signal exists on the input line, the servo will maintain the angular position of the shaft. If the PWM signal changes, the angular position of the shaft changes. The motor shaft of the servos is prevented from moving more than ±90 degrees.

* 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.
* The HCS12 has eight 8-bit channels (or four 16-bit channels). We will use the 16-bit option.

Note that the dragon-12 board has barely enough current to “drive” the servo motor. It needs about 350 mA at about 4.8 V. The current rating for the AC adapter of the Dragon-12 board is about 500-650 mA. Therefore, to power the servos, we will have to use a separate 5V power supply from the. Please refer to the Dragon-12’s for jumper settings. While there are a number of ways to control the servos,

* The circuit will use an external power supply for the servo. The red wire of the servo goes to +5 V terminal of the Power supply; the black is connected to the ground. The grounds of the external power supply and the dragon boards must be connected. However, the power terminals, i.e., the 5 V terminals must never be tied together.
* Use Ports PP7...PP4 for the servo which will be connected to the yellow wire.
* You should verify the duty cycle and the period using an oscilloscope, before using the servo.

**Analog to Digital conversion**: The HCS12 chip has two 8-channel A/D converters, called ATD0 and ATD1. Refer to the pin connections for the dragon-12 board. The dragon-12 plus board has a potentiometer (Trimmer Pot) and has a Light sensor (phototransistor). The goal is to use both inputs to control the position of the servos, one at a time. The output voltage of the potentiometer varies between 0-5 V as the white cap of the pot is turned (gently, of course, otherwise it may break) with a small screw driver. There are many parameters associated with the A/D converters.

The design will use:

* a 10-bit output of the A/D with 24 MHz bus speed.
* a conversion sequence length of 8 to reduce noise from the Pot or the light sensor.

These two sensor outputs will be used

* to change the value of the duty cycle of the PWM signal and
* to vary frequency of the OC5 from 750 Hz to 1250Hz.

**Selection of Sensors using a push button:** The user should be able to select the operating mode by setting a push-button (suggested SW5, debounced) using hardware interrupt. The push button will also choose sensor inputs, to put the servo in the scan mode and a manual position control mode. All of these five mode selections will be in the order mentioned below:

* Rest mode (the servo is not operational and the default position is 0 degrees)
* Sensor source - Potentiometer
* Sensor source - Phototransistor
* Automatic scan mode (-90 to 90 degrees with user configurable speed)
* Manual position control from the serial terminal

**LCD Display & LEDs:** The MSB 8 bit output of the A/D should be displayed on the LEDs; however, turn off the 7-segment display. The name of the selected sensor should be displayed on the first line of the on board LCD. The angular position should also be displayed on the second line of the LCD panel. You are free to choose other parameters for the registers.

**Serial Communication Interface (SCI)**: 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 dragon-12 board using the SCI protocol. 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.

For full points, the design must not use any of the delay functions and cannot include files (“hcs12.h”) from textbook. However, you can use other functions from the textbook as long as you modify the codes to work with CodWarrior’s auto-generated header files.

One important 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 will get a zero in the final. Each partner in the team will upload a report with details of the design so one can understand the system designed by you and modify it.

Please make an appointment using the following link for demo and an oral exam: <https://people.clarkson.edu/~akhondke/Appointments/>