CKRE100: Embedded Systems Programming
Final Assignment: Theremin

Overview:
A theremin is an electronic musical instrument controlled without physical contact from the player. The instrument has two metal antennas that sense the position of the player's hand. The instrument is quite simple to operate. One hand controls the volume (amplitude) and the other controls the pitch (frequency) of the sound produce. Lookup theremin to find out more about the instrument (remember to check out videos). In this assignment, particpants will be creating 2 theremins.

The theremins will be pitch control only. There will be no adjustable volume control. Just on or off.

In this assignment, participant will require several different concepts covered in this course. Most of them are in previous labs but the most important new concept is PWM output.

Common   9 Marks
Although participants must make 2 different theremins using different sensors, they both will use the same common function to generate a signal that produces a tone.

1) To create a sound, the Romeo board must generate signal output to a digital pin. The pin must be connected to the buzzer pin on the IO Trainer Board. The IO trainer board must also be powered (Vcc and GND connected).

2) To create a signal, participant must write a function that initialize the 16-bit timer. The function should be called "initTimer()". The function should:

   a) Use ICRx as TOP

   b) Tie the 16-bit timer to one of the two output pins(OCxA/B) and set it as an output

   c) Clear OCxA/B when match

   d) Fast PWM mode

   e) 1/8 prescale

3) Participant must also write a "tone(uint16_t frequency)" function. The tone function takes in 1parameter which is the frequency of the tone to be generated. This function must control the 16-bit timer to produce a square wave that has 50% duty cycle and the frequency of the wave should match the parameter.

4) Participant must write a "mute(void)" function. This function will stop the tone. This can be done by setting the data direction from output to input and clearing the pin.

5) The main function for both theremins will goes as follow:

   a) The program read in sensor input. The sensor input will vary depending on which theremin participant is working on. The raw sensor input will be normalize to produce a final number between 0 and 4000. This number determins the frequency of the tone.

   b) The program will also read input from one of the 4 momentary switches. When the button is pressed the program will produce a tone at the frequency indicated by the sensor input. When the button is released, there should be no sound.

Theremin1   3 Marks

1) The sensor used in Theremin1 is the Sharp IR distance sensor.

2) Write a function that read the input from the Sharp sensor. Using the raw ADC value, bound and normalize it to output a number between 0 and 4000.

3) When the user's hand is close to the sensor the number should be reaching closer to 0. When the user's hand is further away from the sensor, the value should be close to 4000.

4) Create a file called theremin1.c

Theremin2   3 Marks

1) The sensor used in Theremin2 is the Pololu Reflectance Sensor Array.

2) As the user move their finger across the sensor, the program should return the position of the finger. In Lab4B the sensor returns the position between 1000 and 8000. Modify it such that the position returned should be between 0 and 4000.

3) Create a file called theremin2.c

Submission

Create a video demonstrating both Theremins.
Files should be submitted: theremin.c, theremin2.c, video file