UCR EE/CS 120B

Lab 10: Concurrent synchSMs (Noise maker device) (1 Day)

Simple concurrency with same-period tasks

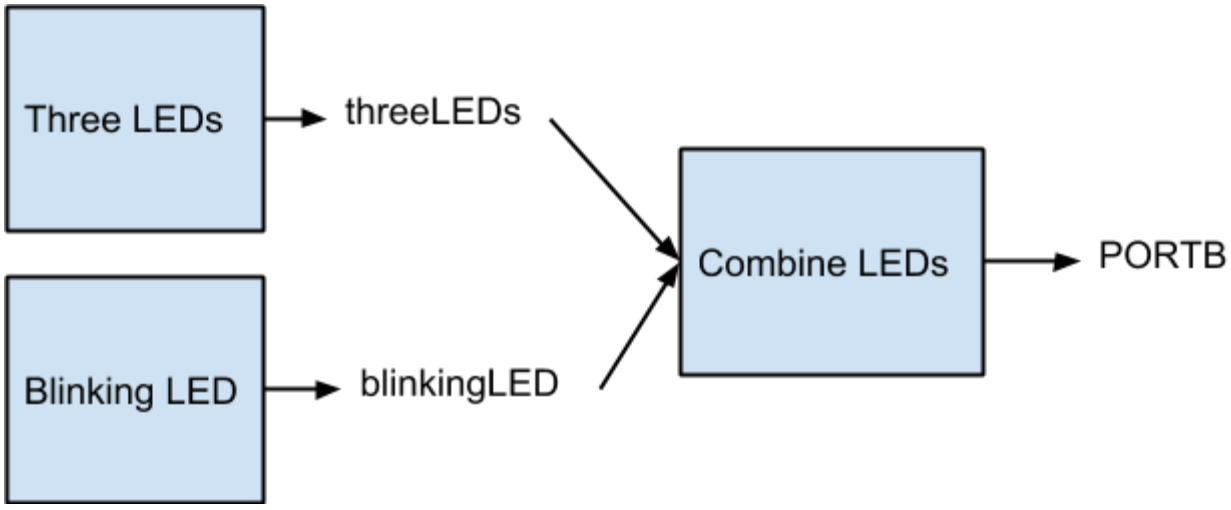
Simply concurrency of same-period run-to-completion tasks can be achieved by ticking each task one at a time at each period, as described in PES. Use the timer abstraction and setup from the previous lab.

Pre-lab

Have your board fully wired and have your synchSMs and your complete C code for Exercise 1. *Be sure to use the clean timer abstraction and the structured method for converting synchSMs to C.*

Exercise 1

Connect LEDs to PB0, PB1, PB2, and PB3. In one state machine (Three LEDs), output to a shared variable (threeLEDs) the following behavior: set only bit 0 to 1, then only bit 1, then only bit 2 in sequence for 1 second each. In a second state machine (Blinking LED), output to a shared variable (bilnkingLED) the following behavior: set bit 3 to 1 for 1 second, then 0 for 1 second. In a third state machine (Combine LEDs), combine both shared variables and output to the PORTB. Note: only one SM is writing to outputs. Do this for the rest of the quarter.



Concurrency with different period-tasks can be achieved by maintaining the elapsed time since the last tick for each task. A simple method ticks the timer at 1 ms and then counts X ticks to determine period X. Let's use that method here (**Do *not* tick the timer at the GCD of the tasks**). Refer to the first two pages of Chp8 of PES for an example.

Video Demonstration: http://youtu.be/Snmt0VFE_Zs

Exercise 2

Modify the above example so the three LEDs light for 300 ms, while PB3's LED still blinks 1 second on and 1 second off.

Video Demonstration: http://youtu.be/i8f5JSteH-U

Generating sound

Sound can be generated by vibrating a membrane that creates sound waves in the air. A membrane vibrating at 261.62 Hz generates a "middle C" sound. A speaker has a membrane that moves when a voltage is applied (typically using a magnet that is moved by the electromagnetic wave of the changing electric current). Toggling a port from 0 to 1 at a frequency in the range of human hearing (around 20 Hz to 20,000 Hz) should generate sound if a speaker is connected to that port. The sound won't be pleasant because it's a square wave rather than a smoother sine wave, so it will sound more like a buzzer than a smooth tone. For more info, see Wikipedia: Audio frequency.

Exercise 3

To the previous exercise's implementation, connect your speaker's red wire to PB4 and black wire to ground. Add a third task that toggles PB4 on for 2 ms and off for 2 ms as long as a switch on PA2 is in the on position.

Video Demonstration: http://youtu.be/UfrIc6xyPyQ

Exercise 4 (Challenge)

Extend the previous exercise to allow a user to adjust the sound frequency up or down using buttons connected to PA0 (up) and PA1 (down). Using our 1 ms timer abstraction, the fastest you'll be able to pulse is 1 ms on and 1 ms off, meaning 500 Hz. You'll probably want to introduce another synchSM that polls the buttons and sets a global variable storing the current frequency that in turn is read by the frequency generator task.

Video Demonstration: http://youtu.be/mt8eznAcp6o

Exercise 5 (Challenge)

Buttons are connected to PA0 and PA1. Output PORTB drives a bank of 4 LEDs. Pressing PA0 increments a binary number displayed on the bank of LEDs (stopping at 9). Pressing PA1 decrements the binary number (stopping at 0). If both buttons are depressed (even if not initially simultaneously), the display resets to 0. *If a button is held, then the display continues to increment (or decrement) at a rate of once per second.* However, if the button is held for 3 seconds, the incrementing/decrementing occurs once per 400 ms. Use synchronous state machines captured in C.

Video Demonstration: http://youtu.be/D33pn3TcjpM

Each student must submit their .c source files according to instructions in the lab submission guidelines. Post any questions or problems you encounter to the wiki and discussion boards on iLearn.