CG2271 Real Time Operating Systems

Tutorial 2

1. Using Google, Wikipedia or any other source you like, research and explain the following terms:

   a. Address, data and control buses.
   b. I/O bridge.
   c. Address decoding.

2. One disadvantage of memory-mapped I/O is that memory locations that are occupied by I/O cannot be used by the processor to store instructions and data. I.e. parts of the memory range become unavailable.

   An approach that is used in microcontrollers like the Atmel Atmega328p is to extend the memory range so that I/O occupies a separate range of addresses from memory. For example memory might occupy addresses 0-4095, while I/O might occupy addresses 4096-8191. Using what you've understood from Question 1 or otherwise, discuss why this same approach is unsuitable for general processors like the Intel processors found in your desktops and notebooks.

3. Given a variable x, write suitable C statements to set bits 3, 5 and 6, and clear bits 0, 1 and 7. If x initially has the value 0xE7, what is the final value in x? Explain all your answers.

4. Write a bare-metal program (i.e. you are not allowed to use Arduino routines) that flashes an LED connected to digital pin 12 on the Arduino Uno twice a second when a push-button connected to digital pin 11 is not pressed, and four times a second when it is pressed. Your code should not affect the state (0 or 1) or direction (input or output) of any other pin.

   Hint: The AVR library provides a _delay_ms function that delays your program for a specified number of milliseconds. This is not part of the Arduino library and you are allowed to use it.

5. A common problem with mechanical switches like push-buttons is "switch bounce", where because of vibrations caused by the switch being pushed and released, the contacts actually open and close many times rather than just once.

   a. Discuss how this would affect the correctness of an embedded device.
   b. Discuss in as much detail as possible how to eliminate this problem through software. You do not need to write any code, perhaps just pseudocode to describe your idea.