Faculty of Science, Engineering and Technology

Computer Systems

Week 4

Overview

In this laboratory session we start look at memory, encoders and stacks.

Purpose: To consolidate your knowledge of Memory, Encoders and Stacks

Task:

Time: This lab is due by the start of your week 5 lab.

Assessment: This lab is worth 1% of your assessment for this unit, and only if demonstrated to your lab demonstrator in the week it is due.

Resources:

- Encoders tutorials
  - Encoders and Decoders (to come)
- Hardware Stacks:
  - Video to come (to come)

Submission Details

You must submit the following files to Canvas:

- A document containing all required work as described below.

Instructions

Theory (Memory, Architectures, Interrupts and Stacks)

1. Review the lecture slides on types of memory and provide a short answers to the following questions (using your own words):
   - 1.1. What is ROM and what is its primary purpose ?
   - 1.2. What is RAM and how is it different from ROM ?
   - 1.3. What is the difference between static RAM and dynamics RAM ?
   - 1.4. What type of memory is typically used in USB thumb drives ? Why shouldn't we rely on this for critical data storage ?
2. Consider a computer with 1GB RAM (1024 MB). Given memory addressing is for each byte, how many bits are needed to address all bytes in the system's RAM ?
3. Give a brief description of the Von Neumann and Harvard computing architectures. What are the fundamental differences between the two and for what is is each designed to achieve ?
4. What is cache memory and what is its primary role ?
5. Explain the concept of an interrupt, and list four common types.
   - 5.1. Polling is an alternative to interrupts ? Briefly explain polling and why it is not commonly used.
6. Explain the general concept of a stack - how do they work, and what is their primary purpose.
   - 6.1. How are stacks useful for handling interrupts ?
   - 6.2. How are stacks useful in programming ?

Provide all the answers to the above questions in your submission document.

Practical - Stacks of Stacks !

7. Start Logisim and open a new canvas
8. Review the lecture slides on building a stack at the top of this lab sheet. We are going to build a 5-bit deep, 1-bit wide stack.
9. Start by building a simple shift register that moves bits from one flip flop to the next each clock pulse. For this you will need a "Data In" pin which sets the next bit to be pushed to the stack, and a clock to invoke the shifting.
10. For your shift register to work as a stack, it needs to be bi-directional. This means the input to any Flip Flop could come from two places - the left or the right. In lectures we discussed a simple "encoder" circuit that selects which of two data inputs is allowed through,

based on a third selection bit. Design the logic for this 2-bit encoder, and demonstrate it to your lab demonstrator.

11. Now incorporate your encoder above to allow bi-directional shifting of your stack. Your stack should:
    11.1. push and pop bits onto and off the stack, using clock pulses and a direction toggle switch
    11.2. show the state of each Flip Flop using LEDs.

Export your circuit as an image and include it in your submission document. Demonstrate your working stack to your lab demonstrator.

12. Modify your stack so that it has the option to read out its contents ***in parallel*** to a separate register of D Flip Flops. This should only occur when a "stack dump" toggle switch (i.e., pin) is enabled. When the toggle is disabled, the register of D Flip Flops should retain the last state read in (and should have LEDs connected to each Flip Flop out showing its state).

Export your circuit as an image and include it in your submission document. Demonstrate your working stack to your lab demonstrator.

When complete:

- Submit your answers (screen shots, etc) in a single document using **Canvas**
- Show your lab demonstrator your working circuits in class (you must do this to get the 1%). Your lab demonstrator may request you to resubmit if issues exist.