Design of Digital Circuits

Lab 8 Supplement: Full System Integration

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Lab 8 Overview

- You will build a whole single-cycle processor and write assembly code that runs on the FPGA board.
- Don't worry! You have 2 sessions for the lab, and it will give you up to 14 points (+6 points from the reports).
- You will learn how a processor is built.
- Learn how the processor communicates with the outside world.
- Implement the MIPS processor and demonstrate a simple "snake" program on the FPGA starter kit.

Lab 8 Sessions

- **Session I:** The Crawling Snake

- **Session II:** Speed Up the Snake

Lab 8 Session I: The MIPS Processor

- Download the Vivado project from the course website
- A lot of parts are already implemented for you!
- What you will have to implement:
  - Compute the Instruction Memory address and read the instruction.
  - Connect the ALU.
  - Compute the Data Memory address and add the necessary wires.
  - Instantiate the Control Unit.

Lab 8 Session I: Memory-Mapped I/O

- Your goal is to control the 7-segment display with your assembly program.

- You will need to complete the I/O controller so the output of the processor will be correctly mapped to the display.

I/O in Assembly

- How do we communicate with the display?

- Memory Mapped I/O
  - We designate specific addresses for the I/O
  - We can read and write to those addresses.
    - Example

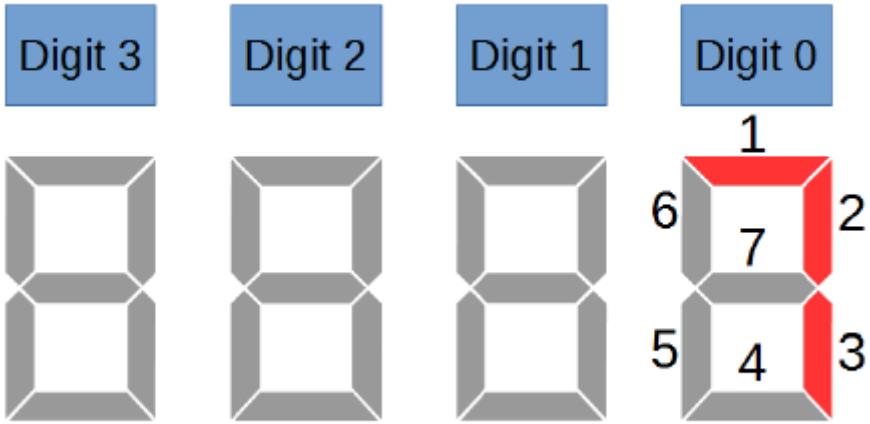
```
# write contents of $t0 into memory at address 0x7FF0
# so that the I/O controller can send it to the display

                    sw $t0, 0x7FF0($0)
```

Lab 8 Session I : The Crawling Snake

- You learned how to write assembly code in Lab 7

- We provide you with the code for a crawling snake on the 7-segment display



- We will run this program on the processor you build in this lab!

Lab 8 Session II: Speed Up The Snake

- You will modify your assembly code to accept inputs.
  - The snake should crawl at different speeds for different inputs.
  - The inputs will be controlled by switches on the FPGA board.
- Modify the I/O controller to accept the inputs.
- Challenges
  - Change the direction of the snake.
  - Change the pattern of the snake.

Last Words

- You will build a whole single-cycle processor and write assembly code that runs on the FPGA board.
- You will learn how a processor is built.
- Learn how the processor communicates with the outside world.
- Implement the MIPS processor and demonstrate a simple "snake" program on the FPGA starter kit.
- You will have some questions to answer in the report.

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