

# Digital Design & Computer Arch.

## Lab 8.1 Supplement: Full System Integration

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Spring 2022

3 May 2022

# Lab 8 Overview

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- 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

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- **Session I:** The Crawling Snake
- **Session II:** Speed Up the Snake

# Lab 8 Session I: The MIPS Processor

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- 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

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- 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

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- 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

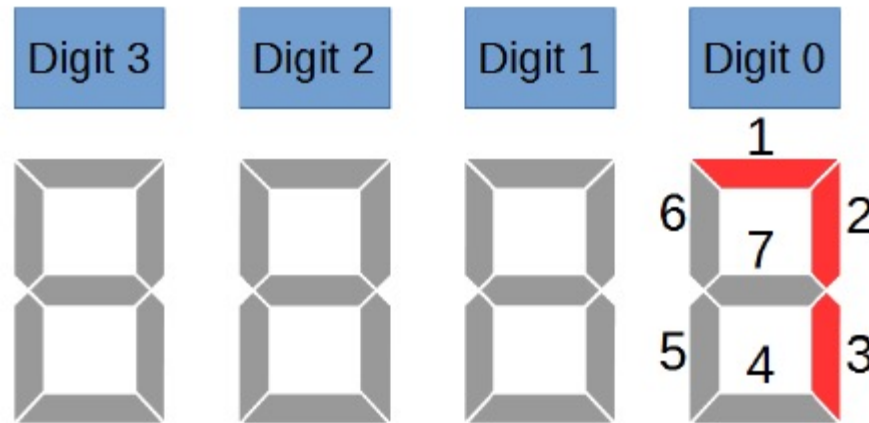
```
# write contents of $t0 into memory at address 0x7FF0  
# so that the I/O controller can send it to the display
```

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

# Lab 8 Session I : The Crawling Snake

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- 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

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- 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

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- 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.

# Report Deadline

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**23:59, 27 May 2022**

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