Design of Digital Circuits

Lab 9 Supplement

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This is the Last Lab

- You still have one more lab session to show your work to the TAs
  - Tuesday, May 29th
  - Wednesday, May 23rd
  - Friday, June 1st

What we have done so far

- You have learned how gates work and how to build small modules out of them
- You combined those modules to more powerful ones
- You learned how to test code via simulation and test benches
- You learned how to write MIPS assembly code
- And finally: You combined all of that knowledge to build a simple processor and even ran your own programs on it

Lab 9 Overview

- Extend the processor from the previous lab: srl, mflo, multu

- Measure the performance of the processor

Lab 9: New Instructions

- The processor can already add and subtract but to be able to efficiently compute we want to add multiplication
- By shifting we can multiply and divide by powers of 2
- You are only required to implement a logic right shift (srl)
  - but feel free to implement a arithmetic right shift and logic left shift
- Every left shift can be implemented by a normal multiplication so we don't need it

Lab 9: How to do 32-Bit Multiplication

- The result of a multiplication of two 32-bit numbers can have up to 64 bits

- Two stage approach:
  - MIPS has special registers (Hi and Lo) where the upper 32 bits of the multiplication result are saved in Hi and the lower 32 ones in Lo (no output from the ALU)
  - mfhi and mflo can then retrieve the values

Lab 9: Performance

- We want to determine the performance of our processor on the example hat you implemented in Lab 7: summing up numbers (once with a loop and once with the Gaussian formula)
- You can use your implementation from Lab 7 and write code calculating the Gaussian formula or use the code that we provide
- Finally, you will test your processor with a test bench

Last Words

- In this lab, you will add instructions to the processor
  - Adding instructions improves the processor design
  - But this comes at a cost: more instructions have to be decoded and more hardware resources are required
- Processor designers need to face these trade-offs
- We hope you have enjoyed the labs
  - You have implemented your own 32-bit processor
  - You have written programs for it
  - You have improved its performance

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