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Dept. of Computer Science and Engineering
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# CSEN 601: Computer System Architecture
# Summer 2017

## Project Description

**Project Name:** Pipelined MIPS datapath simulator

**Grading weight:** This project accounts for 15% of the course mark. A bonus up to 5% **of the project mark** will be given for implementing **one** of the *bonus* features suggested below.

**Project Overview:** The goal of this project is to implement a low-level cycle-accurate pipelined MIPS datapath simulator. Simulating the datapath includes simulating all of its storage components (register file, memories, and pipeline registers) and all of its control signals. This document details the supported instructions, the inputs to the simulator, and the expected outputs.
You should implement the simulator using the LOGISIM logic simulator.

**Team Size:** 1 to 5 students (preferably 2 or more)

**Important Plagiarism notice:** You have to write your own code/design your own circuit from scratch. Projects based on others will receive a grade of **zero** in the entire project (even if it is heavily re-factored/modified, etc…). Examples of such sources include (but are not limited to): other teams, previous year projects, open-source software, tutors, etc…

**Project Deadline:** Wednesday ***August 2nd***, 2017 at 11:59 p.m. Evaluations will take place on Thursday, ***August 3rd***, 2017.

**Instruction set architecture (ISA):** The simulator must support the following MIPS instructions ***only***:

- Arithmetic: add, sub, addi
- Load/Store: lw, sw
- Logic: and, or, sll, andi
- Control flow: beq
- Comparison: slt, slti

**Common Notes:**

- The simulator should assume a pipelined datapath identical to the one presented in the lectures. The pipeline consists of the same five stages discussed in lectures (ID, IF, EXE, MEM and WB).
- Note that, this datapath **does not** detect or handle hazards at all, which means that the input program has to be hazard-free to produce correct results.
- The register file consists of the 32 registers including the $zero register. Register 0 always contains the value 0. You will need to make sure you initialize register 0 appropriately and make sure any attempt to modify it does not succeed.

## Using the LOGISIM logic simulator:

**Important notes:**

- You are required to implement a pipelined MIPS processor on the LOGISIM logic simulator.
- The largest supported memory size in Logisim is 16Mx32 (i.e. it has 24 address lines). That is why you will be using that memory, and you should adjust your design accordingly. The memory in Logisim is word addressable (and not byte-addressable as we are studying in the course). Thus, you need to adjust your design accordingly. For instance, the PC needs to get incremented by 1 instead of 4.
- The whole project and the different modules should be implemented as ***one*** .circ file.

**Testing:**

- In Logisim, load the Program memory with a machine code program (you may use MARS to generate the machine code for any given assembly program.)
- Ensure the clock is at 0; if it is at 1, select the Poke Tool (the hand icon) and click the clock in the bottom left corner to bring it back to 0.
- With the Poke Tool (the hand icon) selected, click the clear button in the circuit's bottom left corner to reset the PC and all registers to 0.
- To execute the program, you can repeatedly click the clock using the Poke Tool to step one half-cycle at a time, or you can select “Ticks Enabled” from the Simulate menu to start the clock running automatically through the program. (You can slow its speed through the “Tick Frequency” submenu.)
- To view current register values, right-click the “regs” circuit and select “View registers”. You can double-click “main” to go back to the overall circuit.

**Bonus Features:**

1. Handling hazards.

**Submission:**

- You should submit a .circ file containing your project to csen601@gmail.com
- The subject of your email should be [Summer Project] Team XX (where XX is your team number).
- The body of your email should include the team members' names and IDs.
- Submit your team to this form by maximum the ***Thursday, July 27th***
  https://goo.gl/forms/jEFZ32lpvm1ZSN4m2
  **Note:** If you do not submit a team, you will be randomly assigned to one.