CS25410 Computer Architecture and Hardware Assignment
Development of Digital Circuits

Thomas Jansen

1 Introduction

This is the assignment for CS25410 "Computer Architecture and Hardware" and comprises 25% of the total marks for the module. It gives information about how and when to hand in, specifies the tasks you have to perform and how you will format your assignment, and highlights the criteria from which the assignment will be marked. Please follow these instructions carefully.

2 Hand-In

For this assignment you have to implement a counter and write a report about it. Please hand-in both parts, the file for the implementation and the report, electronically through Blackboard. The deadline is **on the 18$^{\text{th}}$ of November, 2013**.

By submitting your work to Blackboard you are acknowledging that it is your own work and that you are aware of both the University's and the Department's views on plagiarism.

3 Task

You are asked to implement a counter as a digital circuit in Logisim that is capable of counting forwards and backwards between 0 and 9, displays the current value, and can be reset to 0. The counter counts in a cyclic manner, i. e., when counting forwards it counts to 0 after counting to 9, when counting backwards it counts to 9 after counting down to 0.

The digital circuit has two inputs, one is called d and is used to specify the direction. For $d = 1$ the counter counts forwards (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, ...), for $d = 0$ it counts backwards (0, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 9, 8, 7, ...). The other input is called r and is used for a reset. For $r = 1$ the counter is set to 0 (and it stays at 0 as long as $r = 1$ holds), for $r = 0$ it performs the counting. The counting is triggered by a clock (so that the speed of counting can be set in Logisim by setting the tick frequency). The current value of the counter is displayed in a 7-segment display (using this output element in Logisim).

Your implementation of this counter as digital circuit in Logisim can only use simple logic gates (in Logisim in Gates: NOT, AND, OR, NOR, NAND, XOR, XNOR), a clock (in Logisim in Wiring), Pins for the input (in Logisim in Wiring), the 7-segment display (in Logisim in Input/Output), and flip-flops (in Logisim in Memory: D flip-flop, T flip-flop, J-K- flip-flop, S-R flip-flop). You must not make use of any other components that are available in Logisim (like a shift register or a counter).

You are asked to think about this task and document how you decided to solve it. In particular, discuss design decisions concerning the number and type of flip-flops you use and how you decide how to implement the functionality.

4 Requirements

The assignment asks you to produce two things, a digital circuit (implemented in Logisim) and a report. The digital circuit needs to be a single circuit without sub-circuits saved as a single file Logisim circuit. Logisim can be found at `http://ozark.hendrix.edu/~burch/logisim/` and downloaded from Sourceforge (`http://sourceforge.net/projects/circuit/`). It runs on any machine that supports Java, it can be run without installation, and there are platform-specific versions for Mac and Windows.

The report must include sections "Introduction", "Overview of Design", "Choice of Flip-Flops", "Implementation" and "Conclusion". In case you make use of any external material it also needs to include a session "References". There are no strict lower or upper bounds on the word count. Give a detailed and accessible description and discussion of all aspects without being unnecessarily lengthy.

5 Assignment Marks

This assignment will be assessed under departmental assessment criteria in appendix AA (Development) of the Student Handbook (`http://www.aber.ac.uk/~dcswww/Dept/Teaching/Handbook/AppendixAA.pdf`). The marks breakdown for this component is as follows:

1. Marks for the implementation of the counter:
   - 3 marks for an implementation that counts forward correctly
   - 3 marks for an implementation that counts backward correctly
   - 3 marks for an implementation with a correctly working 7-segment display
   - 2 marks for an implementation with a correctly functioning r input
   - 1 marks for an implementation where the change of counting directions is triggered by the input d as required
2. Marks for the report: 2 marks for each of the required sections, 3 marks for the overall quality (including references if any)
   - 2 marks for the introduction: brief summary of the task and your understanding of it
   - 2 marks for the design overview: description of the general structure and interesting features
   - 2 marks for the choice of flip-flops: discussion of possibilities, decision and reasons for it
   - 2 marks for the implementation: description of experiences and anything noteworthy (e. g, design changes triggered by implementing the original design)
   - 2 marks for the conclusion: summary and discussion what could have been done differently
   - 3 marks for the overall quality (including references if there are any; a report without references can still get full marks here)

The indicative mark breakdown for both sections combined sums to 25. This coursework is worth 25% of the overall mark for CS25410, and so there is a 1 to 1 correspondence between marks for the assignment and the contribution to the overall mark of the module.

6 Plagiarism

Please follow the guidelines from the Student Handbook (`http://www.aber.ac.uk/~dcswww/Dept/Teaching/Handbook/handbook.pdf`) to help you avoid straying from legitimate and desirable co-operation into the area of plagiarism.

- Append a bibliography to your work listing all the sources you have used, including electronic ones.
- Surround all direct quotations with inverted commas, and cite the precise source (including page numbers, or the URL and the date you accessed it if the source is on the Web) either in a footnote or in parentheses directly after the quotation.
- Use direct quotations sparingly and make sure that the bulk of the work is in your own words.
- Even if you don't use direct quotations, important ideas still need to be credited.
- Remember that it is your own input that gives a piece of work merit. Whatever sources you have used, the structure and presentation of the argument should be your own. If you are using electronic sources, dont cut and paste sections into your work. If you are using books or papers, put them aside when you actually sit down to write. In this way you won't be tempted to copy in material that you don't understand, or be at risk of unintentionally copying in more material than a brief quotation, or of accidentally leaving quotations unmarked. Including someone else's work in your own is readily detectable because the style will be different.