CSE 260 – Digital Computers: Organization and Logical Design

Lab 3

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Introduction

In this lab you will implement a finite state machine using VHDL. You will then implement your FSM on an FPGA.

1. Design

We will be implementing the finite state machine from problem number 3 of homework assignment number 3. This finite state machine was used to dictate the behavior of a vending machine. You should use a Moore machine for this lab. Please feel free to use your solution to this problem from the homework as a starting point for this lab. Take a few minutes to go over your FSM and make sure it is complete.

2. Implementation

Create a new project and module and implement your FSM using VHDL. Some things to note:

* You will need to have a way of resetting your FSM. Decide what should happen when the FSM is reset and include this logic in your implementation.

* I do not care how you encode your states, but you need to be consistent. You could even let VHDL decide the encoding for you (hint, hint).

* Your VHDL needs to match the FSM that you submit exactly. We will be checking for this when we grade your submission.

3. Testing

Once you have finished writing code for your FSM, you need to create a testbench for it. Your testbench needs to test every possible transistion in your FSM. Once you are satisfied with your testbench and simulation results, you should print out a copy of your simulation. You should then annotate your simulation printout with each transition that takes place.

4. Hardware Implementation

After successfully simulating and testing your circuit, you should implement it on an FPGA. In the previous lab, all of the buttons and switches were handled for you. This time you will need to connect those components yourself. Download these files and add them to your project:

http://cse.wustl.edu/~dshook/cse260/labs/lab3.zip

The only file you should modify is top.vhd. Comments have been included in this file that tell you exactly where you need to add or change code. You need to do the following:

* Instantiate your FSM component.

* Create signals for your FSM inputs and connect them to the *inBits* signal. Since the clock period is likely to be very fast, we want to have these inputs rely on a button press (pulse). So for example, if I have an input called *inValue*, I would first create a signal for this value then set it as follows:

```
inValue <= inBits(0) and pulse(2);
```

This will ensure that the input will only be read in if button two is pressed. Button two is the button located directly below the knob on the FPGA. You should tie all of your inputs to the same button. Since I used pulse(2) for this input, I now have to use pulse(2) for all of my inputs. The value from inBits should be different for each input. Since I used *inBits(0)* for this input, I can no longer use it for my other inputs, though I could use *inBits(1)* or *inBits(2)*.

* Create signals for your outputs and connect them to the *outBits* signal. There is no need to use buttons for this piece.

* Set a button to reset your FSM. The easiest way to do this is to have a reset input to your FSM module and then map *dBtn(1)* to this input when you instantiate the component.

In general it is best to start setting the lowest bits of *inBits* and *outBits* first, then counting up. In other words, if I have four inputs to my FSM then I should use *inBits(0), inBits(1), inBits(2),* and *inBits(3)*.

Once you have finished modifying top.vhd, you should deploy your project on the FPGA just as you did in the previous lab.

What to Turn In

You must turn in a hard copy of the following:

* Your finite state machine.

* An annotated printout of your simulation, as described above.

* A completed demo form (see below).

You must turn in a digital copy of the following (on Blackboard):

* Your VHDL code for the finite state machine.

* Your VHDL code for the testbench.

* Your completed top.vhd module.

Demo

You must demo your lab on an FPGA before you turn it in. Print out a copy of the demo form from the course website and hand it to the TA. They will walk you through the demo, fill out the form, and then give it back to you. Staple the completed form to the front of your report when you hand it in.