VLSI Systems Design (ESE 355)
Spring 2003
Home Work - 4
Due on April 14, 2003 (Monday)

Acknowledgement: This homework was addapted after one by Prof. R. Vemuri, University of Cincinnati.

This assignment asks you to desgin a finite-state machine (FSM). The following problem is due to Randy Katz.

Your task is to design the control for a newspaper vending machine per the following specification. The newspaper costs 35 cents. The vending machine accepts nickels, dimes and quarters. The customer presses a START button and then begins entering coins, one at a time. The coin sorter logic inside the vending machine (you don't have to design the coin sorter logic, it provides some inputs to your controller) indicates the FSM whether a nickel (N), dime (D), or quarter (Q) has been deposited (assume that the FSM advances from one state to the next when a coin is deposited). If exact change is entered, a mechanical latch is released (Unlatch) so that the customer can get the paper. If the amount of money deposited exceeds 35 cents, change is given if possible i.e. if there is enough change in the repository. Otherwise, deposited coins are refunded to the customer and the mechanical latch is not released.

Assume that the money just deposited is kept separately from previous accepted coins. The later are held in a coin depository. Change is given in dimes and nickels. If one nickel is in the depository, a signal N1 is asserted. If two nickels are there, N2 is true (note: N1, N2 will be both asserted if the repository contains two or more nickels), and so on. D1, D2, ... behave the same way for dimes. If sufficient change is available, the FSM pulses a nickel release (NR) or a dime release (DR) signal to release one coin of change at a time (it would jam the machine to release more than one coin at a time).

If insufficient change is available, the coins just deposited are refunded by the FSM by asserting a refund (REF) signal. Otherwise, the deposited coins join the repository as the FSM asserts a join (JOIN) signal.

Consider for a moment the signals that indicate the number of nickels and dimes available to make change (N1, N2, ..., D1, D2, ...). What is the maximum number of nickels that might be needed at any time? What is the maximum number of dimes that might be needed? Understanding the answers to these questions will help you in deciding how many N1, N2, ... signals and how many D1, D2, ... signals there sould be.

Following tasks should be completed as part of this assignment:

1. Develop a specification for the vending machine controller. Briefly explain your specification using state diagrams, state-transition tables, boolean equations or a combination of these. Submit all specifications in your report.

2. Using these specifications, design the Magic layout-level implementation of the FSM using apropriate cells from the standard-cell library also used in Homework 3.

3. In your report, submit the Magic layout and the irsim simulation results for various combinations of inputs. Inputs should be selected such that the correctness of the FSM is illustrated for various situations.