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Digital Systems

Wintersemester 2017/2018

Serie 8

Issue Date: Monday, 15.01.2018
Submission Date: Wednesday, 24.01.2018

Presentation tasks

Task 1

The 'Present factory' of Santa Claus shall be controlled by a sequential circuit. The presents shall be subjected to the clock of the sequential circuit of a visual quality control, whereby a signal "damage= 0" is signalled when the present is intact and "damage= 1" in other cases. Single damaged presents can be tolerated. Moreover, there is a warning lamp W which will light up for one clock in case of a damaged present. In the case that two presents out of four consecutive presents are found to be damgaed, an emergency switch ($N = 1$) shall be triggered and the control network shall be reset to the starting position.

(a) Identify the inputs and outputs of the sequential circuit.

(b) Draw an automaton graph of the sequential circuit with the least possible number of states.

Task 2

Fill in the following table. Provide the corresponding values that will match the inputs / input of the flip flops in order to generate the desired state modifications (i.e. the modifications of the saved values). If it is a 'don't care' situation, i.e. if either a 1 or a 0 can be applied at the input, mark it with an 'X'.

current state	next state	R-S-Flip flop		J-K-Flip flop		D-Flip flop	T-Flip flop
		R	S	J	K		
0	0						
0	1						
1	0						
1	1						

Homework

Task 1 - Short questions

(a) Give a correct definition of a minterm and a primeterm?

(b) How many selection inputs does one need for a 7-to-1 multiplexer?

$2^1/_2$, $2^1/_2$ points

Task 2

Design a sequential circuit for the usage of a pinball machine. A pinball machine consists of a table with an angled table top. On the upper side a ball can be injected. The player uses levers to keep the ball from rolling off the table through a hole. In one game, a limited amount of balls is distributed. Once all the balls available have been used and have rolled off the table, the game is lost. On the table top there additionally are several obstacles. If the ball touches these obstacles, the player gets additional points. Reaching as many points as possible before all available balls have been used, is the goal of the game.
The counting of points, the light and sound effects when touching obstacles and the control of the levers are handled internally. Your sequential circuit only has to model the following tasks:
Your pinball machine offers the option to buy exactly one ball when entering a coin. The ball injection is automatic (you don't have to model it). A player can not have more than 3 balls at the same time. The pinball machine will award an bonus ball for each 1.000.000 points, though only, if the player not already has 3 balls. Finally, a ball can be lost. You may assume, that none of the events will ever happen concurrently in the system. Instead, only one of the three events may occur at every tick of the clock. This makes it possible to use 'don't care's' in your truth table to optimize your automaton.
Furthermore, your pinball machine plays different melodies when important actions happen. One of them is played, once the 1.000.000 points mark has been reached (no matter, whether the bonus ball is awarded or not). Another is played, when losing the ball, and finally there is another individual melody for losing your last ball (different from losing earlier balls).
You may assume, that the automaton is in an entry state, in which no game takes place, after turning it on.

(a) Identify the in- and outputs of the sequential circuit. Encode the outputs with a few bits as possible.

(b) Draw an automaton graph of the sequential circuit with as few states as possible.

(c) Give a complete truth table.

(d) Create a disjunctive Minimal form of the transition functions of the states and the function of the output variables.

(e) Draw a layout using a FPLA with D-flip flops.

5, 20, 10, 15, 10 points

Task 3

Show that a Master Slave R-S-flip flop can take an undefined state in case of one input combination.

10 points

Task 4

(a) Design a sequential circuit for a synchronous Modulo-10-Counter. The counter shall be built using T-flip flops.

(b) Extend your circuit using a reset input so that one can reset the counter to zero.

15, 10 points