CS1026 – Digital Logic Design

Last one – Inspection Design Methods

Alistair Morris [1]

[1]Distributed Systems Group
Trinity College Dublin

March 20, 2016

Today's Overview

1. Classical Design
2. Example 1
3. Example 2
4. Q&A

Limitations with Classical Design I

We can only use the classical design method with:

- A small number of inputs
- States
- Outputs

The K-maps required become too difficult to draw and work with.

Limitations with Classical Design II

The Inspection Design Method provides ways to write the excitation equation using:

- A timing diagram
- A state diagram
- A ASM chart

For a synchronous Finite State Machine.

Limitations with Classical Design III

By observing or inspecting the present state (PS) and next state (NS) for each state variable:

- We can write the D, T and $J - K$ excitation equations

The equations derived using inspections do not give minimum equations however.

Limitations with Classical Design IV

We have two inspection methods:

1. The Set-Hold 1 Method
2. Clear-Hold 0 Method

Limitations with Classical Design V

We use the following table to write D excitation equations directly from a state diagram, ASM chart or timing diagram.

Present State (PS/NS) Y_i	Y_i^+	Di	Comment	User for 1s (Set-Hold 1)	Use for 0s (Clear-Hold 0)
0	0	0	Hold 0 transition		Di’
0	1	1	Set transition	Di	
1	0	0	Clear transition		Di’
1	1	1	Hold 1 transition	Di	

Limitations with Classical Design VI

The "Set-Hold 1 Method" obtains the D excitation equations for the 1s of each state variable (flip-flop outputs):

- $Di = \sum$(PS.external input conditions for set) $+$ $\sum$(PS.external input conditions for hold 1) for $i = 1, 2, 3, \ldots$

Limitations with Classical Design VII

The "Set-Hold 0 Method" can be used to obtain the D excitation equations for the 0s of each state variable (flip-flop outputs)

- $Di = \sum$(PS.external input conditions for clear) + $\sum$(PS.external input conditions for hold 0) for $i = 1, 2, 3, \ldots$

Limitations with Classical Design VIII

For both of the methods:

- If we have not completely specified FSM meaning and some state values as dont cares
  - Enter them as such so that we can use them in later reduction

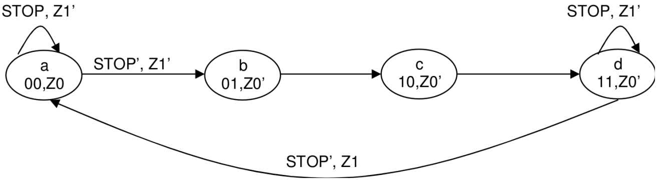
Simple Example I

Obtain the excitation equations for the following state diagram of a Mixed Moore-Mealy machine:

- State – Y1Y2
- Input – STOP
- Output – Z0Z1

Simple Example II

Our state chart:



Simple Example III

By inspecting all state transitions ($Y1 = 0 \implies Y1^+ = 1$) and all Hold 1 transitions ($Y1 = 1 \implies Y1^+ = 1$):

- We can write the D1 excitation equation:
  - $D1 = Y1'.Y2 + Y1.Y2' + Y1.Y2.STOP$

Simple Example IV

Now repeat the previous step for D2 using Y2 transitions..

- By observing (or inspecting) all transitions $(Y2 = 0 \implies Y2^{+} = 1)$ and all Hold 1 transitions $(Y2 = 1 \implies Y2^{+} = 1)$
  - We can write the D1 excitation equation: $D2 = Y1'.Y2'.STOP' + Y1.Y2' + Y1.Y2.STOP$

Simple Example V

Alternatively..
We could also look for the 0s function using Clear-hold 0 method to find $D1'$ and $D2'$

Simple Example VI

Based on the state diagram $Z0$

- We see that we have a Moore-type output
  - It only depends on the state variables (flip-flop outputs)

Simple Example VII

Y1 \ Y2	0	1
0	1	0
1	0	0

Z0 = Y1'.Y2'

We will use a K-map with state variables to find minimized the $Z0$ equation

Simple Example VIII

$Z1$ is a Mealy-type output since it depends on both the state variables and external input

STOP \ Y1Y2	00	01	11	10
0	0	0	1	0
1	0	0	0	0

Z0 = Y1.Y2.STOP’

Again we use a K-map with state variables plus external input to find minimize $Z1$ equation

Real World Example I

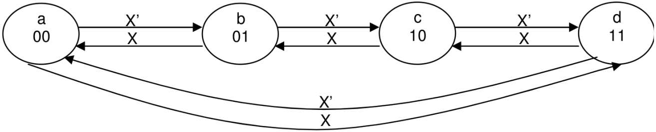
A question

Design a synchronous 2-bit Binary up down counter that counts up when input signal $X = 0$ and counts down when input signal $X = 1$

- State – $Y1Y2$
- Input – X

Real World Example II

The state chart:



Real World Example III

Use the *Set Clear Method* to obtain the J-K excitation equations for the 1s of each state variable (flip-flop outputs):

- By observing all the sets ($Y1 = 0 \implies Y1^{+} = 1$), we can write the J1 excitation equation:
  - $J1 = Y1'.Y2.X' + Y1'.Y2'.X = Y2'.X + Y2.X'$

Real World Example IV

Also..

- By observing all the clears ($Y1 = 1 \implies Y1^{+} = 0$), we can write the K1 excitation equation:
  - $K1 = Y1.Y2'.X + Y1.Y2.X' = Y2'.X + Y2.X'$

Real World Example V

Now we repeat this for the second Flip Flop:

- By observing all the sets ($Y2 = 0 \implies Y2^{+} = 1$), we can write the J2 excitation equation:
    - $J2 = Y1'.Y2'.X' + Y1'.Y2'.X + Y1.Y2'.X' + Y1.Y2'.X = Y1'.Y2' + Y1.Y2' = Y2'$

Real World Example VI

Finally:

- By observing all the clears (Y2 =1 Y2 =0), we can write the K2 excitation equation:
  - $K2 = Y1'.Y2.X' + Y1'.Y2.X + Y1.Y2.X' + Y1.Y2.X = Y1'.Y2 + Y1.Y2 = Y2$

References (Homework) I