CSE 232 LOGIC CIRCUIT AND DESIGN

PROJECT 1

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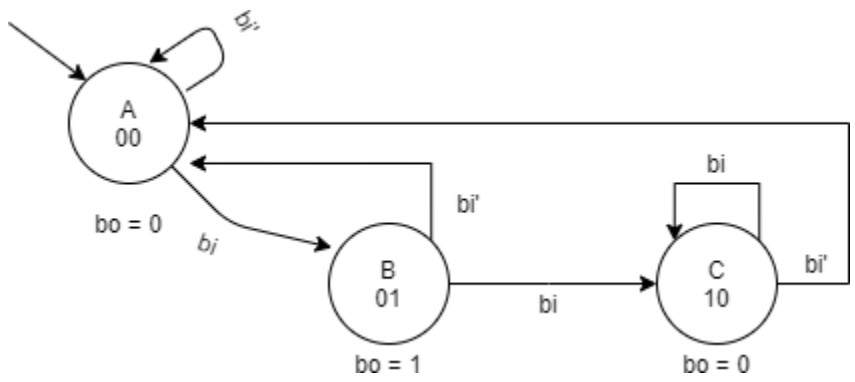
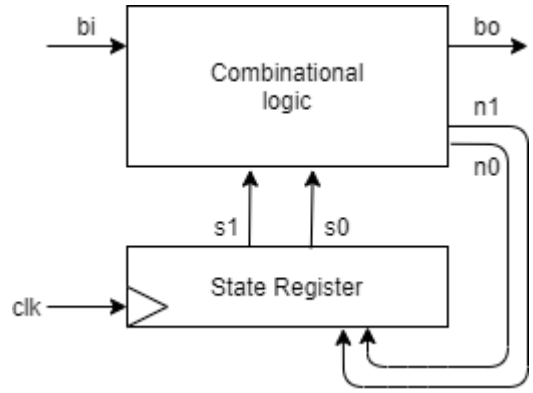
I put another fsm in front of the buttons to be sure that only one led shifts forward/backward each time the button is pressed regardless of how long the button is pressed. In other words, I wait for the button to be released after shifting forward / backward one led.

Button Press Synchronizer:

State Diagram:



FSM:



Truth Table:

	Inputs			Outputs		
	s1	s0	bi	n1	n0	bo
A	0	0	0	0	0	0
	0	0	1	0	1	0
B	0	1	0	0	0	1
	0	1	1	1	0	1
C	1	0	0	0	0	0
	1	0	1	1	0	0
unused	1	1	0	0	0	0
	1	1	1	0	0	0

Boolean Expressions:

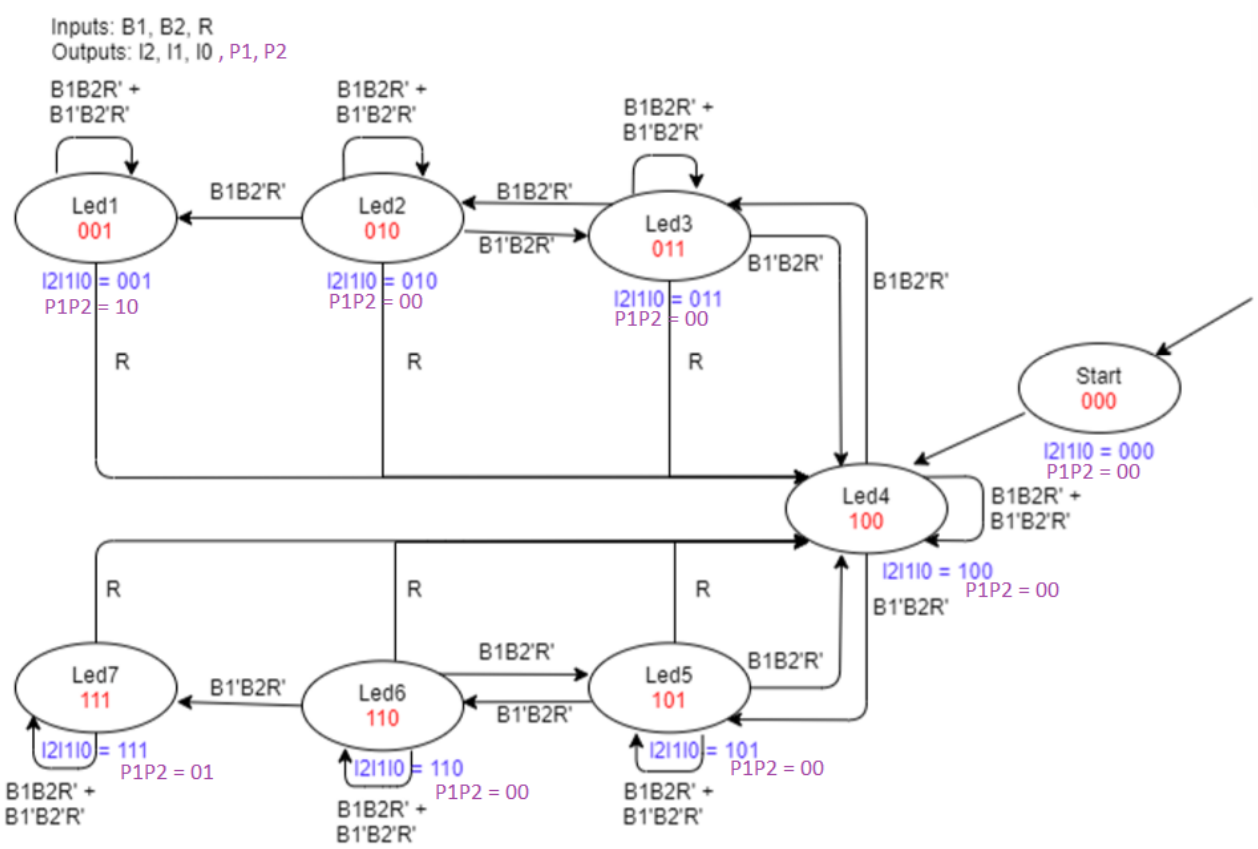
n1 = s1's0bi + s1s0'bi = (s1's0 + s1s0') bi = (s1 XOR s0) bi

n0 = s1's0'bi

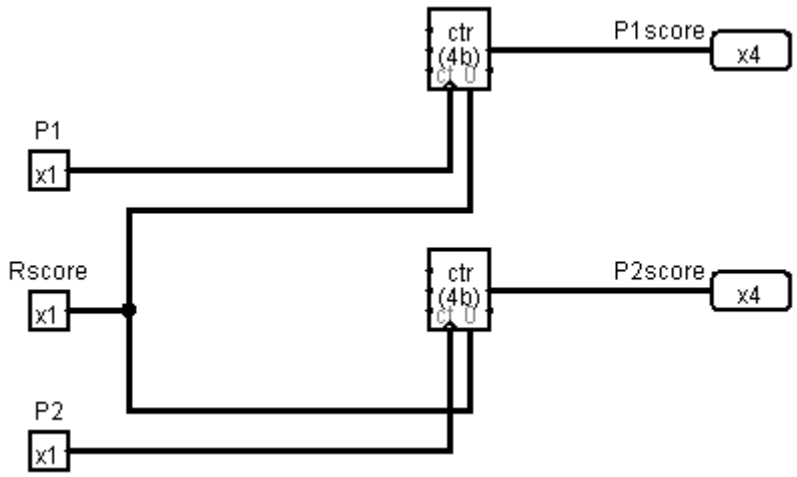
b0 = s1's0bi' + s1's0bi = s1's0 (bi' + bi) = s1's0

THE GAME

State Diagram:



Datapath for scores:



Decoder for 7 Segment Display:

	Inputs				Outputs						
	n3	n2	n1	n0	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1

Boolean Expressions:

a' = n3'.n2'.n1'.n0 + n3'.n2.n1'.n0'
= n3'.n1'.(n2'.n0 + n2.n0')
= n3'.n1'.(n2 XOR n0)

b' = n3'.n2.n1'.n0 + n3'.n2.n1.n0'
= n3'.n2(n1'.n0 + n1.n0')
= n3'.n2.(n1 XOR n0)

c' = n3'.n2'.n1.n0'

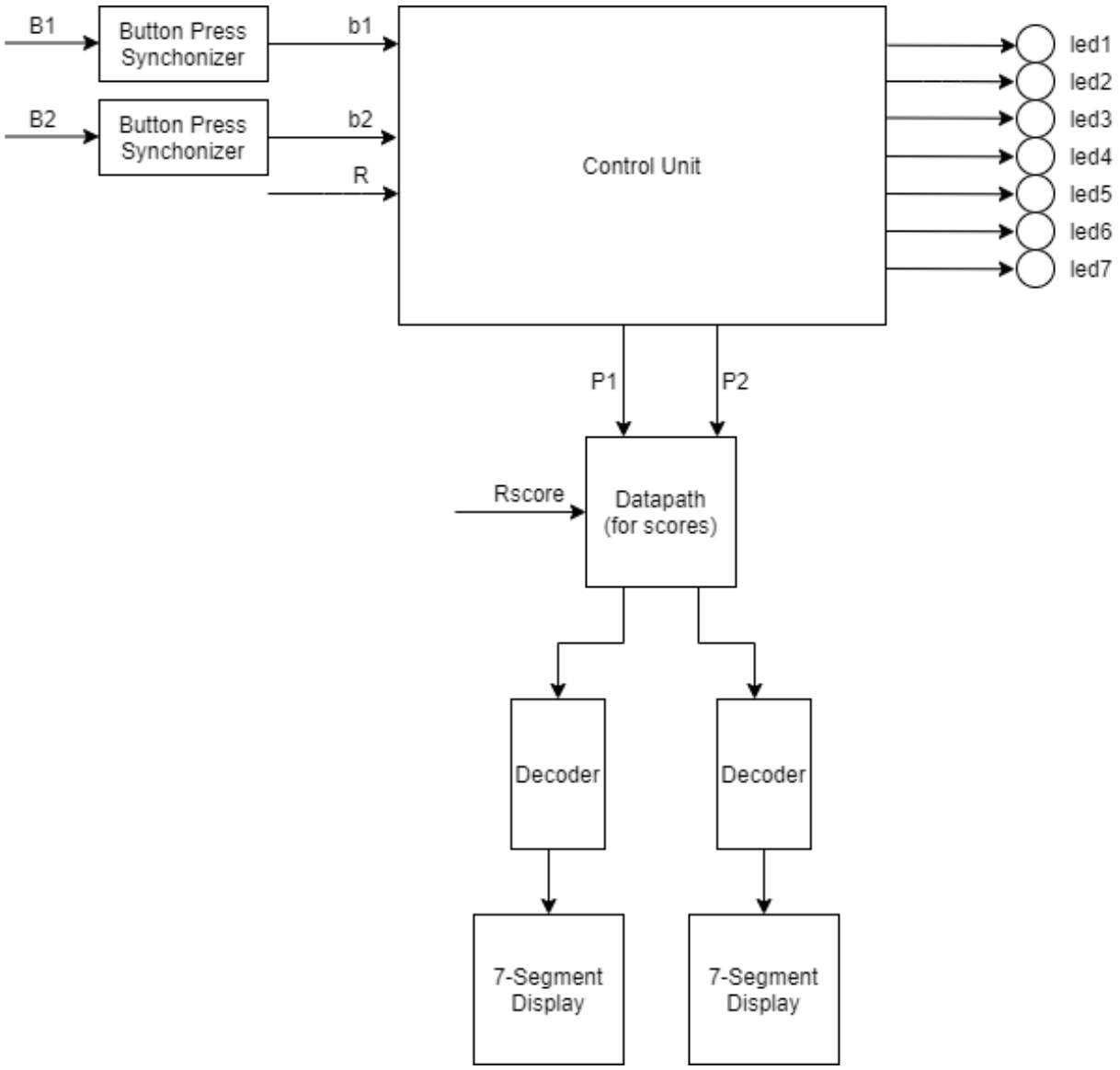
d' = n3'.n2'.n1'.n0 + n3'.n2.n1'.n0' + n3'.n2.n1.n0
= n3'.n1'.(n2'.n0 + n2.n0') + n3'.n2.n1.n0
= n3'.n1'(n2 XOR n0) + n3'.n2.n1.n0

e = n3'.n2'.n1'.n0' + n3'.n2'.n1.n0' + n3'.n2.n1.n0' + n3.n2'.n1'.n0'
= n3'.n0'.(n2'.n1' + n2.n1) + n2'.n0'.(n3'.n1 + n3.n1')
= n3'.n0'.(n2 XNOR n1) + n2'.n0'.(n3 XOR n1)

f' = n3'.n2'.n1'.n0 + n3'.n2'.n1.n0' + n3'.n2'.n1.n0 + n3'.n2.n1.n0
= n3'.n2'.(n1'.n0 + n1.n0') + n3'.n1.n0.(n2' + n2)
= n3'.n2'.(n1 XOR n0) + n3'.n1.n0

g' = n3'.n2'.n1'.n0' + n3'.n2'.n1'.n0 + n3'.n2.n1.n0
= n3'.n2'.n1'.(n0' + n0) + n3'.n2.n1.n0
= n3'.n2'.n1' + n3'.n2.n1.n0

FSM:


B1
Button Press Synchonizer
b1
B2
Button Press Synchonizer
b2
R
Control Unit
led1
led2
led3
led4
led5
led6
led7
P1
P2
Rscore
Datapath (for scores)
Decoder
Decoder
7-Segment Display
7-Segment Display

Truth Table:

	Inputs						Outputs							
	R	B1	B2	s2	s1	s0	l2	l1	l0	n2	n1	n0	P1	P2
Start	1	1	1	0	0	0	0	0	0	1	0	0	0	0
	1	1	0	0	0	0	0	0	0	1	0	0	0	0
	1	0	1	0	0	0	0	0	0	1	0	0	0	0
	1	0	0	0	0	0	0	0	0	1	0	0	0	0
	0	1	1	0	0	0	0	0	0	1	0	0	0	0
	0	1	0	0	0	0	0	0	0	1	0	0	0	0
	0	0	1	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Led1	1	1	1	0	0	1	0	0	1	1	0	0	1	0
	1	1	0	0	0	1	0	0	1	1	0	0	1	0
	1	0	1	0	0	1	0	0	1	1	0	0	1	0
	1	0	0	0	0	1	0	0	1	1	0	0	1	0
	0	1	1	0	0	1	0	0	1	0	0	1	1	0
	0	1	0	0	0	1	0	0	1	0	0	1	1	0
	0	0	1	0	0	1	0	0	1	0	0	1	1	0
	0	0	0	0	0	1	0	0	1	0	0	1	1	0
Led2	1	1	1	0	1	0	0	1	0	1	0	0	0	0
	1	1	0	0	1	0	0	1	0	1	0	0	0	0
	1	0	1	0	1	0	0	1	0	1	0	0	0	0
	1	0	0	0	1	0	0	1	0	1	0	0	0	0
	0	1	1	0	1	0	0	1	0	0	1	0	0	0
	0	1	0	0	1	0	0	1	0	0	0	1	0	0
	0	0	1	0	1	0	0	1	0	0	1	1	0	0
	0	0	0	0	1	0	0	1	0	0	1	0	0	0
Led3	1	1	1	0	1	1	0	1	1	1	0	0	0	0
	1	1	0	0	1	1	0	1	1	1	0	0	0	0
	1	0	1	0	1	1	0	1	1	1	0	0	0	0
	1	0	0	0	1	1	0	1	1	1	0	0	0	0
	0	1	1	0	1	1	0	1	1	0	1	1	0	0
	0	1	0	0	1	1	0	1	1	0	1	0	0	0
	0	0	1	0	1	1	0	1	1	1	0	0	0	0
	0	0	0	0	1	1	0	1	1	0	1	1	0	0

Led4	1	1	1	1	0	0	1	0	0	1	0	0	0	0
	1	1	0	1	0	0	1	0	0	1	0	0	0	0
	1	0	1	1	0	0	1	0	0	1	0	0	0	0
	1	0	0	1	0	0	1	0	0	1	0	0	0	0
	0	1	1	1	0	0	1	0	0	1	0	0	0	0
	0	1	0	1	0	0	1	0	0	0	1	1	0	0
	0	0	1	1	0	0	1	0	0	1	0	1	0	0
	0	0	0	1	0	0	1	0	0	1	0	0	0	0
Led5	1	1	1	1	0	1	1	0	1	1	0	0	0	0
	1	1	0	1	0	1	1	0	1	1	0	0	0	0
	1	0	1	1	0	1	1	0	1	1	0	0	0	0
	1	0	0	1	0	1	1	0	1	1	0	0	0	0
	0	1	1	1	0	1	1	0	1	1	0	1	0	0
	0	1	0	1	0	1	1	0	1	1	0	0	0	0
	0	0	1	1	0	1	1	0	1	1	1	0	0	0
	0	0	0	1	0	1	1	0	1	1	0	1	0	0
Led6	1	1	1	1	1	0	1	1	0	1	0	0	0	0
	1	1	0	1	1	0	1	1	0	1	0	0	0	0
	1	0	1	1	1	0	1	1	0	1	0	0	0	0
	1	0	0	1	1	0	1	1	0	1	0	0	0	0
	0	1	1	1	1	0	1	1	0	1	1	0	0	0
	0	1	0	1	1	0	1	1	0	1	0	1	0	0
	0	0	1	1	1	0	1	1	0	1	1	1	0	0
	0	0	0	1	1	0	1	1	0	1	1	0	0	0
Led7	1	1	1	1	1	1	1	1	1	1	0	0	0	1
	1	1	0	1	1	1	1	1	1	1	0	0	0	1
	1	0	1	1	1	1	1	1	1	1	0	0	0	1
	1	0	0	1	1	1	1	1	1	1	0	0	0	1
	0	1	1	1	1	1	1	1	1	1	1	1	0	1
	0	1	0	1	1	1	1	1	1	1	1	1	0	1
	0	0	1	1	1	1	1	1	1	1	1	1	0	1
	0	0	0	1	1	1	1	1	1	1	1	1	0	1

Boolean Expression:

l2 = s2

l1 = s1

l0 = s0

n2’ = (led1) R’B1B2 s2’s1’s0 + R’B1B2’ s2’s1’s0 + R’B1’B2 s2’s1’s0 + R’B1’B2’ s2’s1’s0 +
(led2) R’B1B2 s2’s1s0’ + R’B1B2’ s2’s1s0’ + R’B1’B2 s2’s1s0’ + R’B1’B2’ s2’s1s0’ +
(led3) R’B1B2 s2’s1s0 + R’B1B2’ s2’s1s0 + R’B1’B2’ s2’s1s0 +
(led4) R’B1B2’s2s1’s0’

n2’ = R’s2’s1’s0 + R’s2’s1s0’ + R’(B1 + B1’B2’)s2’s1s0 + R’B1B2’s2s1’s0’

n2’ = R’s2’(s1 XOR s0) + R’(B1 + B1’B2’)s2’s1s0 + R’B1B2’s2s1’s0’

n1 = (led2) R’B1B2 s2’s1s0’ + R’B1’B2 s2’s1s0’ + R’B1’B2’ s2’s1s0’ +
(led3) R’B1B2 s2’s1s0 + R’B1B2’ s2’s1s0 + R’B1’B2’ s2’s1s0 +
(led4) R’B1B2’ s2s1’s0’ +
(led5) R’B1’B2 s2s1’s0 +
(led6) R’B1B2 s2s1s0’ + R’B1’B2 s2s1s0’ + R’B1’B2’ s2s1s0’ +
(led7) R’B1B2 s2s1s0 + R’B1B2’ s2s1s0 + R’B1’B2 s2s1s0 + R’B1’B2’ s2s1s0

n1 = R’(B2 + B1’B2’)s2’s1s0’ + R’(B1+B1’B2’)s2’s1s0 + R’B1B2’ s2s1’s0’ + R’B1’B2 s2s1’s0 +
R’(B2+B1’B2’)s2s1s0’ + R’s2s1s0

n1 = R’(B2 + B1’B2’)s1s0’ + R’(B1+B1’B2’)s2’s1s0 + R’B1B2’ s2s1’s0’ + R’B1’B2 s2s1’s0 + R’s2s1s0

n0 = (led1) R’B1B2 s2’s1’s0 + R’B1B2’ s2’s1’s0 + R’B1’B2 s2’s1’s0 + R’B1’B2’ s2’s1’s0 +
(led2) R’B1B2’ s2’s1s0’ + R’B1’B2 s2’s1s0’ +
(led3) R’B1B2 s2’s1s0 + R’B1’B2’ s2’s1s0 +
(led4) R’B1B2’ s2s1’s0’ + R’B1’B2 s2s1’s0’ +
(led5) R’B1B2 s2s1’s0 + R’B1’B2’ s2s1’s0 +
(led6) R’B1B2’ s2s1s0’ + R’B1’B2 s2s1s0’ +
(led7) R’B1B2 s2s1s0 + R’B1B2’ s2s1s0 + R’B1’B2 s2s1s0 + R’B1’B2’ s2s1s0

n0 = R’s2’s1’s0 + R’(B1 XOR B2)s2’s1s0’ + R’(B1B2+B1’B2’)s2’s1s0 + R’(B1 XOR B2)s2s1’s0’ +
R’(B1B2 + B1’B2’)s2s1’s0 + R’(B1 XOR B2)s2s1s0’ + R’s2s1s0

n0 = R’s0(s2’s1’ + s2s1) + R’(B1 XOR B2)s0’(s2’s1 + s2) + R’(B1B2 + B12B2’)s0(s2 XOR s1)

P1 = s2’s1’s0

P2 = s2s1s0

Situations expected to work in this project:

- This game starts at the fourth led.
  (It works in my project.)
- Returning the game to the initial state in any state by pressing the reset button
  (It works in my project.)
- The led is shifted when only one of the buttons is pressed. The first button pressed between the two buttons is valid. If both buttons are pressed at the same time, this is an invalid move.
  (It works in my project.)
- One led shifts each time the button is pressed regardless of how long the button is pressed.
  (It works in my project.)
- The new game does not start without pressing the reset button while in the first led or the seventh led.
  (It works in my project.)