Introduction to Digital Logic

Lecture 23

Vending Machine
Digital System Design

- Control and Datapath Unit paradigm
  - Separate logic into datapath elements that operate on data and control elements that generate control signals for datapath elements
  - Datapath: Adders, muxes, comparators, counters, registers (w/enables)
  - Control Unit: State machines/sequencers
Vending Machine Controller

- Consider a vending machine that sells Coke, Diet Coke, Sprite and Dr. Pepper
  - Drinks cost $1
  - Sensors indicate (for 1 clock cycle) when a user has entered a nickel, dime, quarter, or dollar bill
  - Max. input amount is $2 (beyond that the machine is not responsible for counting)
  - Individual buttons for each drink allow the user to select their drink and if at least $1 has been entered, a release signal for each drink should be asserted
  - Making change will be considered in a future lab
Control and Datapath Unit paradigm
- Separate logic into datapath elements that operate on data and control elements that generate control signals for datapath elements
- Datapath: Adders, muxes, comparators, counters, registers (w/enables)
- Control Unit: State machines/sequencers
Money Collection & Release FSM

- Consider the state machine only for money collection and release signal generation

Pseudocode for collection algorithm:

```
On Reset (power on)

Collect

M >= 100

M >= 100

Release

Button_Press / REL_EN=0

Button_Press / REL_EN=1
```
Money Collection & Release FSM

- Consider the state machine only for money collection and release signal generation.

Pseudocode for collection algorithm:

Let $M = 0$
while ($M < 200$ )
    if $S5 == 1$ then $M = M + 5$
    if $S10 == 1$ then $M = M + 10$
    if $S25 == 1$ then $M = M + 25$
    if $S100 == 1$ then $M = M + 100$
Money Collection & Release FSM

• Consider the state machine only for money collection and release signal generation

Pseudocode for collection algorithm:

Let M = 0
while( state == COLLECT )
    if S5 == 1 then M = M + 1
    if S10 == 1 then M = M + 2
    if S25 == 1 then M = M + 5
    if S100 == 1 then M = M + 20
Money Collection Datapath

- 4-to-1, 6-bit mux
- 6-bit Reg.
  w/ Enable
- 6-to-1, 6-bit mux
- Priority
  Encoder
- Comparator

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Money Release Datapath
Sample Operation Waveform
CLK
/RESET
SNSR25
BTN_DP
LD
M
M >= 100
State
REL_EN
REL_DP
/RESET
0 5 (25) 10 (50) 15 (75) 20 (100) 0
COLLECT SEL/REL COLLECT