# ECE 212 eHomework 3 Report

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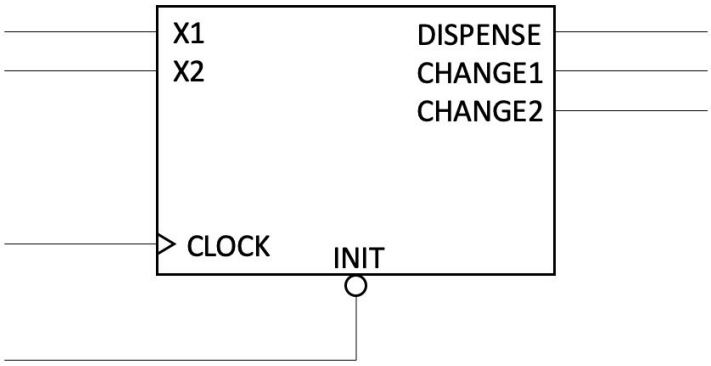
The purpose of this project was to design a vending machine controller as a MEALY state machine. The vending machine stocks two selections, A and B. A costs 5 cents and B costs 10 cents. The vending machine accepts only nickels. The vending machine gives back change if the price of a selection is exceeded. A maximum of 15 cents can be in the machine. The input and output of the state machine are shown below.

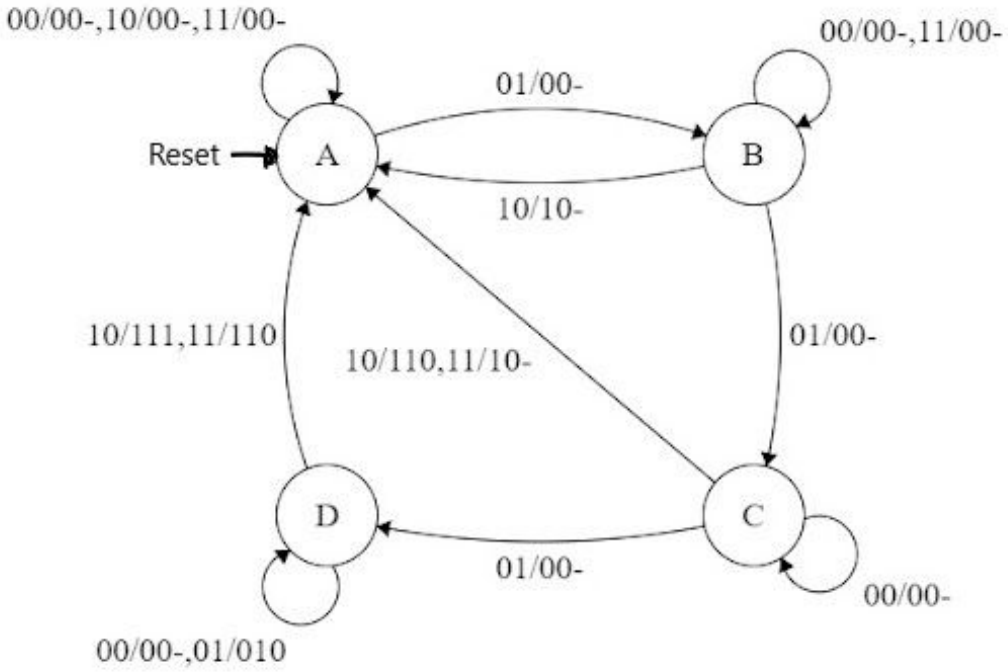



The actions represented by each combination of x1 and x2 are shown in table 2.

| x1 | x2 | Action |
|---|---|---|
| 0 | 0 | Customer does nothing |
| 0 | 1 | Customer is depositing a nickel into the machine |
| 1 | 0 | Customer is attempting to select item A |
| 1 | 1 | Customer is attempting to select item B |

**Table 2: The values of inputs x1 x2 indicate what action the customer is taking.**

The state diagram is shown below. State A represents 0 cents in the machine. State B represents 5 cents in the machine. State C represents 10 cents in the machine. State D represents 15 cents in the machine. In the 3 bit output, the MSB represents the dispense output, which is 1 if an item must be dispensed. The second bit represents the change1 output. The LSB represents the change2 output. Input is in the format of X1X2.




A table clarifying the change given to the customer based on the change1 and change2 output values is displayed in table 3.

| CHANGE1 | CHANGE2 | Meaning |
|---|---|---|
| 0 | - | No change |
| 1 | 0 | Give 5-cents worth of change |
| 1 | 1 | Give 10-cents worth of change |

**Table 3: The values of outputs CHANGE1 and CHANGE2 signify the amount of change.**

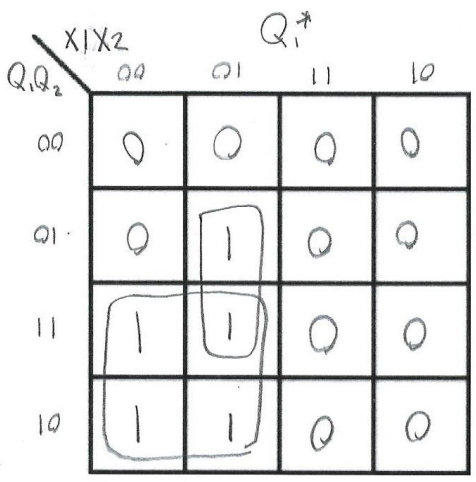
The symbolic state table for the state machine is shown below.

| State | X1X2=00 | X1X2=01 | X1X2=11 | X1X2=10 |
|---|---|---|---|---|
| A | A/00- | B/00- | A/00- | A/00- |
| B | B/00- | C/00- | B/00- | A/10- |
| C | C/00- | D/00- | A/10- | A/110 |
| D | D/00- | D/010 | A/110 | A/111 |

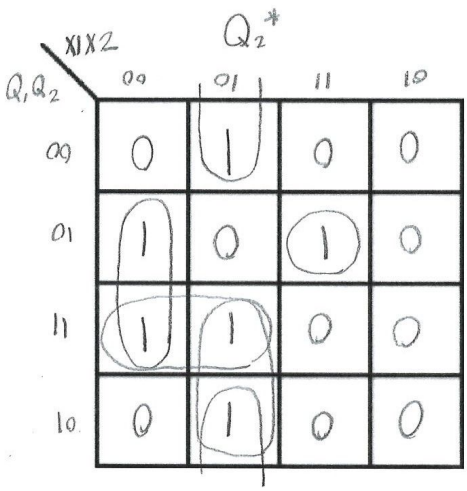
The corresponding encoded state transition table is shown below.

| Q1 Q2 | X1X2=00 | X1X2=01 | X1X2=11 | X1X2=10 |
|---|---|---|---|---|
| 0 0 | 00/00- | 01/00- | 00/00- | 00/00- |
| 0 1 | 01/00- | 10/00- | 01/00- | 00/10- |
| 1 0 | 10/00- | 11/00- | 00/10- | 00/110 |
| 1 1 | 11/00- | 11/010 | 00/110 | 00/111 |

The K-maps for the encoded state transition table are shown below with the reduced functions for the next states and the outputs.




$Q_1^* = X1' \cdot Q_1 + X1' \cdot X2 \cdot Q_2$




$Q_2^* = X1' \cdot X2' \cdot Q_2 + X1' \cdot X2 \cdot Q_2' + X1 \cdot X2 \cdot Q_1' \cdot Q_2 + X1' \cdot Q_1 \cdot Q_2$

Dispense

| $Q_1Q_2$ \ $X1X2$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 0 | 1 |
| 11 | 0 | 0 | 1 | 1 |
| 10 | 0 | 0 | 1 | 1 |

$Dispense = X1 \cdot Q_1 + X1 \cdot X2' \cdot Q_2$

Change 1

| $Q_1Q_2$ \ $X1X2$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 0 | 0 |
| 11 | 0 | 1 | 1 | 1 |
| 10 | 0 | 0 | 0 | 1 |

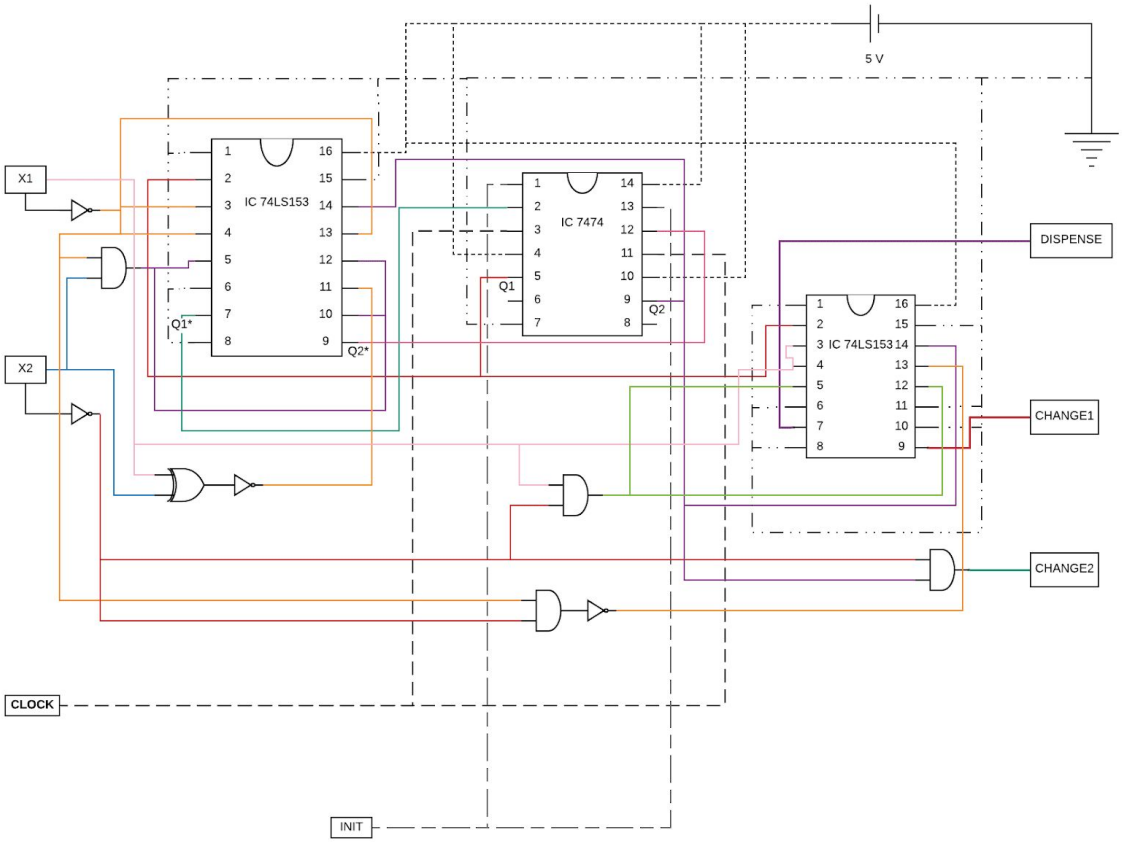
$Change\ 1 = X2 \cdot Q_1 \cdot Q_2 + X1 \cdot X2' \cdot Q_1$

Change 2

| $Q_1Q_2$ \ $X1X2$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | d | d | d | d |
| 01 | d | d | d | d |
| 11 | d | 0 | 0 | 1 |
| 10 | d | d | d | 0 |

$Change\ 2 = X2' \cdot Q_2$

Using the existing power supply, LED, and AD2 circuits from eHomework 1, the adder was constructed with a 7474 IC, 74LS153(2) IC, 7404 IC, 7408 IC, and 7486 IC. The schematic for the design is shown below.




The connections to the Analog Discovery 2 are shown in table 4.

| Signal | AD2 Probe |
|---|---|
| CLOCK | DIO-0 |
| INIT | DIO-1 |
| X1 | DIO-2 |
| X2 | DIO-3 |
| DISPENSE | DIO-4 |
| CHANGE1 | DIO-5 |
| CHANGE2 | DIO-6 |

**Table 4: Signal connection**

The constructed circuit is shown below.