SP18 Final Project ECE36200 Vending Machine

Objective:
Write an assembly program to simulate a **Vending Machine**. Customers can purchase at least 4 various products from this vending machine. It can operate in normal mode or energy-efficient mode to save energy usage. Besides, it has maintenance mode that allows a technician to perform maintenance tasks. Customer experience is a high priority; therefore, the vending machine has membership card, item suggestions based on the rankings of items' popularity and surprise sale. The overall objective is to create a program that replicates the interface of a vending machine that is user friendly and free of glitches.

Peripheral Simulations:

1. *Stepper Motor:* The stepper motor is meant to replicate the retracting gate at the end of coin chute.

    - In normal mode, when a coin is inserted into the coin slot and roll downwards through the coin chute, the retracting gate will open by spinning in clockwise direction for one full revolution to let the coin drop into the storage box. After that, it will spin another one full revolution in counter-clockwise direction to close the retracting gate.

    - In maintenance mode (see Switches), the retracting gate will open by spinning in clockwise direction for one full revolution for the technician to retrieve the coins. After all the coins are retrieved, it will close by spinning in counter-clockwise direction for one full revolution.

2. *DC Motor:* The DC motor is meant to replicate the motor that spins the coil in vending machine to push the items forward.

    - In normal mode, the motor will spin at 100% duty cycle to push an item to fall into the collecting tray of vending machine.

    - In energy-efficient mode (see Switches), the motor will spin at 30% duty cycle to push an item to fall into the collecting tray.

3. *Keypad:* The keypad is the primary way that the customers and technician provide input to the vending machine.

    - In normal mode, customers can use the keypad to make selection on the items they want to purchase, to increase/decrease the quantity of the selected item, to maneuver through next screen by pressing "OK" and to cancel their purchase by pressing "Cancel".

    - Sometimes, customers have tough time deciding on what to purchase. To improve the customer experience, there should be a "Suggestion" button which provide suggestions to customers based on the ranking of item popularity. The most

purchased item should rank at the top of the list, followed by the second most purchased item, and so on.

- When the customers swiped their membership card (see IRQ), the keypad will allow customers to key in their member ID and allow them to choose whether they want to claim their rewards.

- In energy-efficient mode, keypad is used to wake vending machine from idle state.

- In maintenance mode, the technician enters the admin password using the keypad before permission is granted to perform maintenance tasks. The technician also uses the keypad to maneuver through different screens and make selections related to maintenance tasks.

- Overall, keypad should allow the customers and technician to maneuver the vending machine smoothly.

4. *Potentiometer:*

- In normal mode, the potentiometer is meant to replicate the cover on collecting tray. Customers open the cover by spinning the potentiometer to the maximum value. After they have retrieved their purchased items, they need to reset it back to zero value.

- In maintenance mode, the potentiometer is meant to replicate the action of stock replenishment. Refer to Appendix A for a detailed explanation.

5. *LCD:* The LCD screen is the main display for the vending machine.

- In normal mode, the LCD screen will first display all items that can be purchased and the corresponding keys to press to select on the items. If the selected item is out of stock, LCD should display "Sorry, Item Out of Stock" message. If an available item is chosen, the LCD will then display the quantity of the item that customers want to purchase followed by instruction to proceed to the next step. If the selected quantity is beyond the available amount, LCD will display "Sorry, Quantity Selected is Not Available" followed by the currently available amount. Then, the LCD will show the amount of money that has been loaded into the vending machine followed by instruction to proceed. After that, the LCD will show the motion graphic of the purchased item being pushed forward by the coil. Refer to Appendix B for a more detailed explanation. Lastly, the LCD will display a message to ask customer to collect their purchased items at the collecting tray followed by a "Thank you!" message.

- The LCD will list out the ranking of items' popularity when "Suggestion" button is being pressed. Most purchased item should be at the top of the list, followed by second most purchased item, and so on.

- When the customers swipe their membership card, the LCD screen will display a message to ask for the member ID. If correct member ID is entered, LCD will show reward points that they have collected so far followed by an instruction to redeem the reward. Each item purchased by the members worth one reward point on their respective membership cards.

- In energy-efficient mode, the LCD display will be turned off when it's left idle for 1 minute.

- In maintenance mode, the LCD will display a screen to ask the technician to enter admin password. The maintenance mode if entered will display the two options for maintenance tasks which are "Collect Coins" and "Stock Replenishment". In "Collect Coin" maintenance task, the LCD will display the number of coins currently present in the vending machine. In "Stock Replenishment" task, the LCD screen will display the quantity of items for all eight available items as well as which items that the technician choose to restock.

- During surprise sale, the LCD will blink with the message "SURPRISE SALE!!!" to notify customers about the sale.

6. *Push Button:* Push button is meant to replicate the action of inserting coin into the vending machine.

   - Each press on the push button is equivalent to inserting a quarter (25¢).

7. *Switches:*

   - If Switch 1 is low, the vending machine operates in normal mode. When Switch 1 is high, the vending machine operates in maintenance mode. In normal mode, customers can purchase items from the vending machine. In maintenance mode, it allows the technician to perform maintenance tasks on the vending machine.

   - When Switch 1 is high, it will ask the technician to enter admin password. Then, technician can choose whether to "Collect Coins" or do "Stock Replenishment". In "Collect Coins", technician can collect all coins currently present in the vending machine. In "Stock Replenishment", technician can choose to restock the items that are running short in supply.

   - If and only if it is in maintenance mode, technician can push Switch 2 to low to operate in normal mode or push Switch 2 to high to make the vending machine operate in energy-efficient mode. In normal mode, the vending machine will have highest brightness on its LEDs, speaker will keep playing songs to attract customers and LCD screen will **always** remain on. In addition, the DC motor will spin in 100% duty cycle.

   - In energy efficient mode, the LED will go dim (~50% of full brightness), no songs will be played through the speaker and nothing will be displayed in the LCD screen when it's left idle for 1 minute. Customer/Technician will then need to press on any key to wake the vending machine from idle state. On top of that, the DC motor will spin at 30% duty cycle.

8. *Speaker (Port T):* The speaker is meant to replicate the sound system of the vending machine.

   - In normal mode, the speaker will play songs to grab customers' attention and attract them to make a purchase from the vending machine.

   - In both normal and energy-efficient mode, the speaker will produce clink-ing sound to imitate the sound effect of inserting coin when customers is in payment process.

After the purchased items are being pushed down to the collecting tray, a 5 seconds song will be played.

- During surprise sale, the speaker will another 5 seconds song to notify customers about the sale.

9. *LEDs (Port S):* The LEDs are meant to replicate the lighting system of the vending machine.

- In normal mode, the LEDs will light up at 100% brightness all the time.

- In energy-efficient mode, the LEDs will light up at 100% when it's in use and it will light up at 50% brightness after it's left idle for 1 minute.

- In both normal and energy-efficient mode, the LEDs will blink at normal rate after the purchased items are being pushed down to the collecting tray.

- During surprise sale, the LEDs will blink at fast rate to notify customers about the sale.

10. *IRQ:* IRQ is meant to replicate the action of swiping a membership card.

- Membership card is crucial element designed to build customer loyalty to purchase from the vending machine. When the membership card is swiped, customers will be asked for their membership card ID. It will then display the reward points that the customers have collected by far on their card and the instruction to redeem reward. Customers who have 5 or more reward points are eligible to claim the reward. 5 reward points is equivalent to getting one free item. Customers can also choose to continue collecting reward points and not to redeem their reward even though they are qualified. Each item purchased by the customers will receive one reward point on their respective membership cards.

11. *Three extra items:* Your group should come up with three extra features, simple or complex. You are encouraged to be creative in your additional features.

12. *RTI*:
- To gain popularity on your vending machine, you decided to have a 50% off **surprise sales** every <u>5 minutes</u>. During your surprise sales, LEDs will blink at a fast rate to notify the customers about it, speakers will play attractive songs to gain attention and LCD screen will blink with the message "SURPRISE SALE!!!" for 5 seconds. The first customer to make a purchase will then be able to receive 50% off promotion.
- Overall, RTI controls the timing of the whole simulation.

Requirements:

1. The vending machine should have a minimum of **4 items** that can be purchased. Each item should be initialized to start with maximum quantity which is 16.

2. A minimum of 5 membership cards should be initialized in the system, complete with member ID and reward points.

3. The overall layout of your system should be easy to understand and make sense. The user should be able to operate the system with little to no training or explanation. If you are unsure if the layout of your system makes sense, ask one of your TAs or fellow students to try to move through your system.

4. No delay loops are allowed (except keypad debouncing), you must utilize the Real Time Interrupt RTI.

Note:
You are encouraged to be creative and make this project your own. You can make reasonable assumptions in the development of this project, but keep in mind that the assumptions must make sense to the player/admin (and to the Lab TAs).

FOR YOUR PROJECT 10% OF THE GRADE WILL BE BASED ON EXTRAS THAT YOU WILL CREATE ON YOUR OWN. YOUR ARE ENCOURAGED TO BE CREATIVE THE MORE COMPLEX THE EXTRA THE MORE POINTS ARE EARNED.
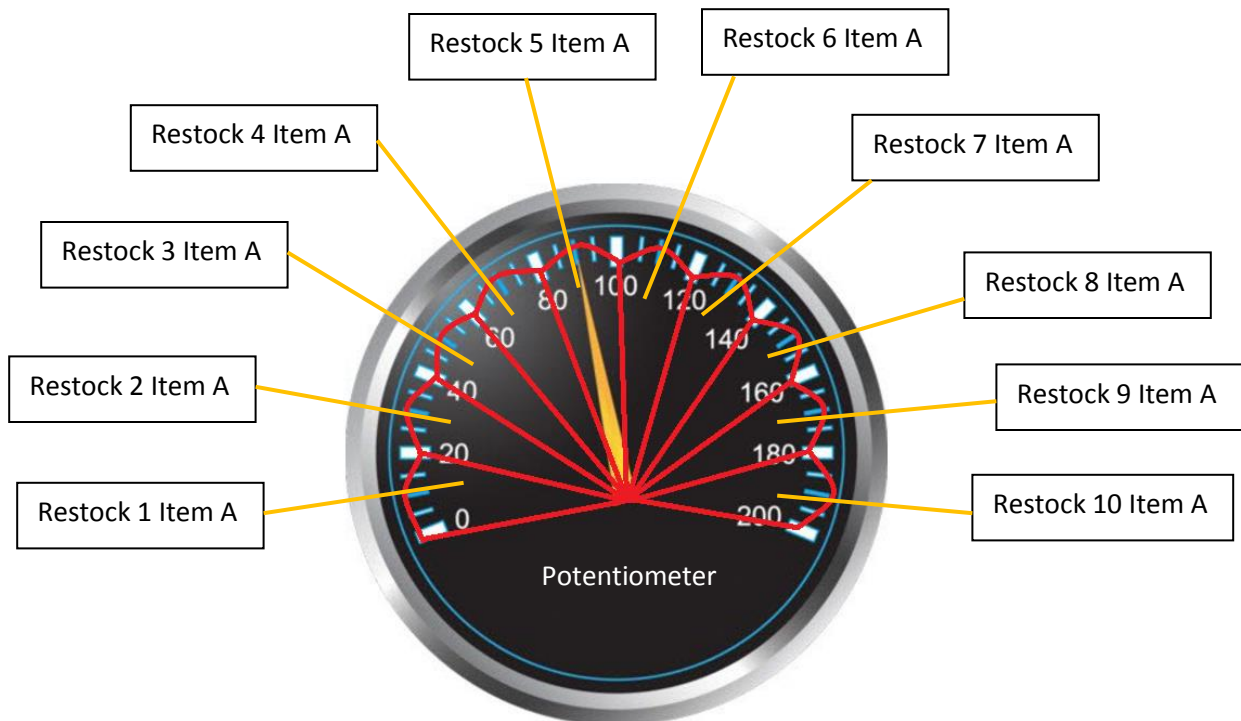
Appendix A

Stock Replenishment

The maximum quantity for each item is set to be 16. Let's make 3 assumptions here to better illustrate the example for stock replenishment:

- The item that the technician wanted to restock is called Item A.
- Initially the vending machine had 16 of Item A, after some time customers purchased 10 of Item A and it's left with 6 of Item A inside the vending machine.
- The maximum value that the potentiometer can go on the board is 200. Please note that the maximum value that the potentiometer can go vary from board to board.

So, when the potentiometer knob is twisted by the technician to replenish stock, the division of potentiometer should follow the following equation:

$$Division\ of\ Potentiometer = \frac{Maximum\ value\ of\ Potentiometer}{Maximum\ Quantity - Quantity\ Left} = \frac{200}{16 - 6} = 20$$

Therefore, 1 Item A will be restocked when the value of potentiometer is between 0 to 20, 2 Item A will be restocked when the value of potentiometer is between 21 to 40, 3 Items A will be restocked when the value of potentiometer is between 41 to 60 and so on. The value doesn't have to be completely accurate, but what important here is that there must be a clear division between each quantity that's going to be replenished.

Appendix B

Motion Graphic

The capacity of LCD screen in our board is 16 characters per line and there are 2 lines.

Let's assume that we have 10 of Item B currently sitting in the vending machine, then a customer purchase 2 of Item B (represent by '#' symbol). The motion graphic will be same what similar to what's shown below:
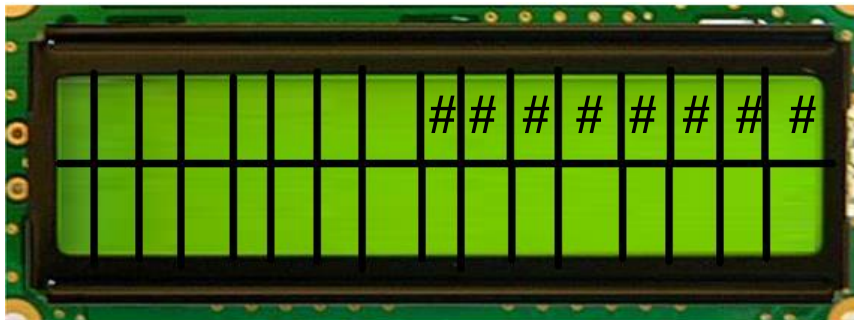
First, it will display the quantity that is available in the vending machine which is 10.
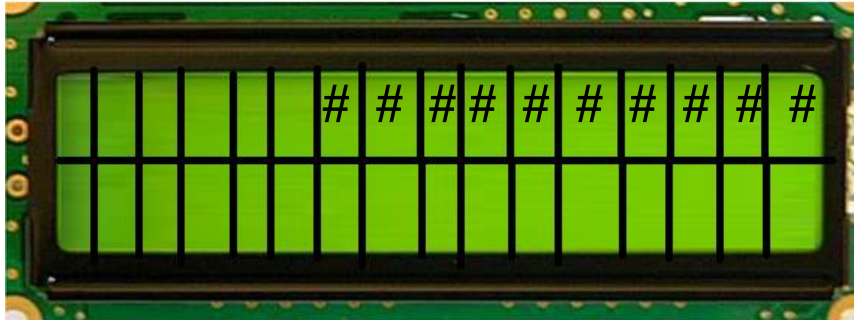
Then, it is followed by the first purchased Item B dropped into collecting tray.
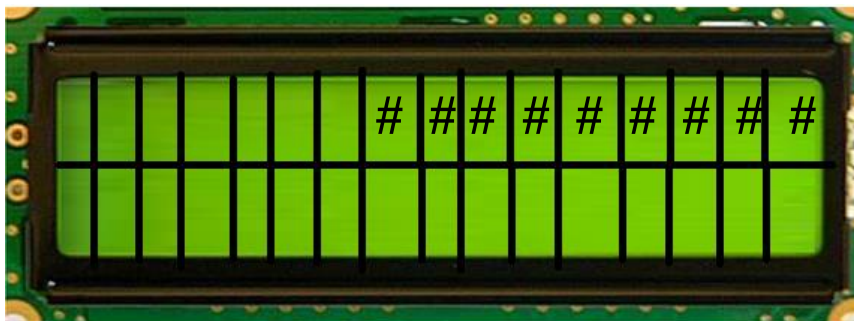
Then, it is followed by the second purchased Item B dropped into collecting tray.

If Item B is restock, the number of '#' should change accordingly too.