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# DESIGN AND IMPLEMENTATION OF AN FSM-BASED CONTROL SYSTEM FOR AN AUTOMATIC CANDY VENDING MACHINE

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**Abstract.** This paper presents the design and implementation of a finite state machine (FSM) based control system for an automatic candy vending machine. The vending machine accepts three types of coins: nickels (5 cents), dimes (10 cents), and quarters (25 cents), and it dispenses candy once the total value of coins deposited reaches 25 cents or more. The FSM is designed to monitor the incoming coin inputs and maintain the current total amount of money deposited. Upon detecting that the accumulated amount is sufficient to purchase candy (25 cents or more), the FSM triggers a signal to dispense the candy and subsequently resets to its initial state. A reset signal is used to return thevalue of coins deposited reaches 25 cents or more. The FSM is designed to monitor the incoming coin inputs and maintain the current total amount of money deposited. Upon detecting that the accumulated amount is sufficient to purchase candy (25 cents or more), the FSM triggers a signal to dispense the candy and subsequently resets to its initial state. A reset signal is used to return the system to its idle state after candy is delivered. The proposed FSM provides an efficient way to handle the acceptance of various coins, update the total amount, and control the candy dispensing process.

## I.INTRODUCTION

Vending machines are utilized to appropriate different items like espresso, beverages, postcards and gem dealers and so on when cash is embedded into it. The Vending machines are more sensible and functional than the traditional acquiring of items. The vending machines can be discovered all over in schools , universities, rail route stations and airplane terminals and so forth for offering tickets, drinks, in banks for gave that tokens to clients.

In this report a strategy is proposed to plan a FSM based Vending machine. The machine can be gotten to through cash or via card. This machine additionally bolsters a scratch off highlight, which implies that the client can withdraw the interest and the cash will be discounted back to client. The machine can be utilized at better places like schools, universities and rail route stations. This sort machines diminishes cost, time and work.

The Vending machine can likewise be gotten to via card framework in which the card is confirmed via card scanner or the attractive and contrasts it with the data stowed in the host system. After the confirmation the card requests a pin number which is given by the client and afterward the item can be chosen and the exchange could be possible. The card framework can be helpful for consistent clients which help for a speedier exchange cash framework. In nations like Japan Vending machines additionally convey platinum and jewels furthermore gem specialists, all things considered card framework can be helpful choice than cash framework. The card framework will be more achievable than the cash framework for more measures of exchanges. The beneath pictures are the strategies for the Vending machines. The Vending machines are fundamentally FPGA based machines. These are more adaptable, programmable and can be reinvented. Beforehand CMOS, SED and micro controller based machines are utilized. However, these CMOS and SED based machines are most drawn out than the FPGA based and micro controller based machines. Anyhow, in micro controller based machines in the event that we need to upgrade the configuration, we need to change the entire construction modeling however where as

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in FPGA framework we can simply expand the quantity of items.

## II.EXISTING SYSTEM

The working of the vending machine circuit using VHDL revolves around effectively managing state transitions and controlling outputs through a finite state machine (FSM). The circuit operates on a 9V DC power supply, and its initial state is IDLE, where the system remains inactive until power is supplied and access is authorized. To begin the operation, the Light Switch (S1) and Key Switch (S2) are turned on, allowing power to flow through the circuit and enabling authorized personnel to activate the system. The System ON/OFF Switch (S3), being normally closed (NC), ensures the continuity of the circuit, while the Empty Switch (S7) remains closed as long as items are available, maintaining the system in an operational state. Once a coin is inserted, the Money Switch (S4), which is normally open (NO), gets activated, energizing Relay RL1. This latching relay remains energized even after the switch is released, ensuring that the circuit stays powered and the system transitions to the READY state. In this state, the Button Lamp (L3) lights up, indicating that the machine is prepared for item selection. The selection lamps (L4, L5, L6) are also illuminated to guide the user. When the user presses the Button Switch (S5), Relay RL2 is activated, allowing the user to make a selection using the Select Switch (S6). The chosen output activates the corresponding lamp and motor (L4 and M1, L5 and M2, or L6 and M3), transitioning the system to the DISPENSE state. During dispensing, the selected motor runs to release the product, and the corresponding lamp remains lit to indicate the active selection. If the machine becomes empty, the Empty Switch (S7) opens, causing the OUT_OF_STOCK state to be activated. In this state, Lamp L8 turns on to indicate that the machine needs refilling, and the system disables further selections to prevent erroneous operations. The system remains locked in this state until the stock is replenished, ensuring user safety and reliable operation. Furthermore, safety interlocks and logical checks are integrated within the VHDL code to prevent simultaneous selections and manage abnormal conditions, making the vending machine control system robust and efficient. The use of relays not only helps maintain the state but also provides necessary isolation and protection for electrical components, while indicator lamps and button lamps offer real-time feedback to users and operators.

**Conclusion:**

The design of a candy vending machine using VHDL provides a direct, hardware-centric solution to the problem of automation, but it introduces challenges in terms of complexity, flexibility, debugging, and resource management. While this approach may be suitable for educational purposes or small-scale embedded systems, a microcontroller-based system would likely be more practical and cost-effective for larger-scale applications.

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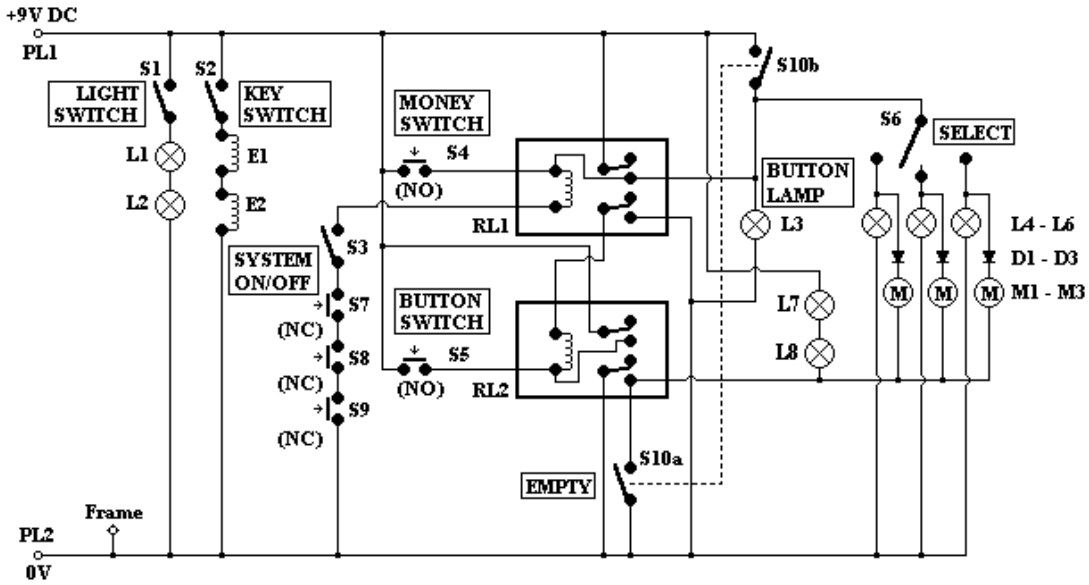


**Fig: 1.internal architecture of candy vending machine**

## III PROPOSED SYSTEM

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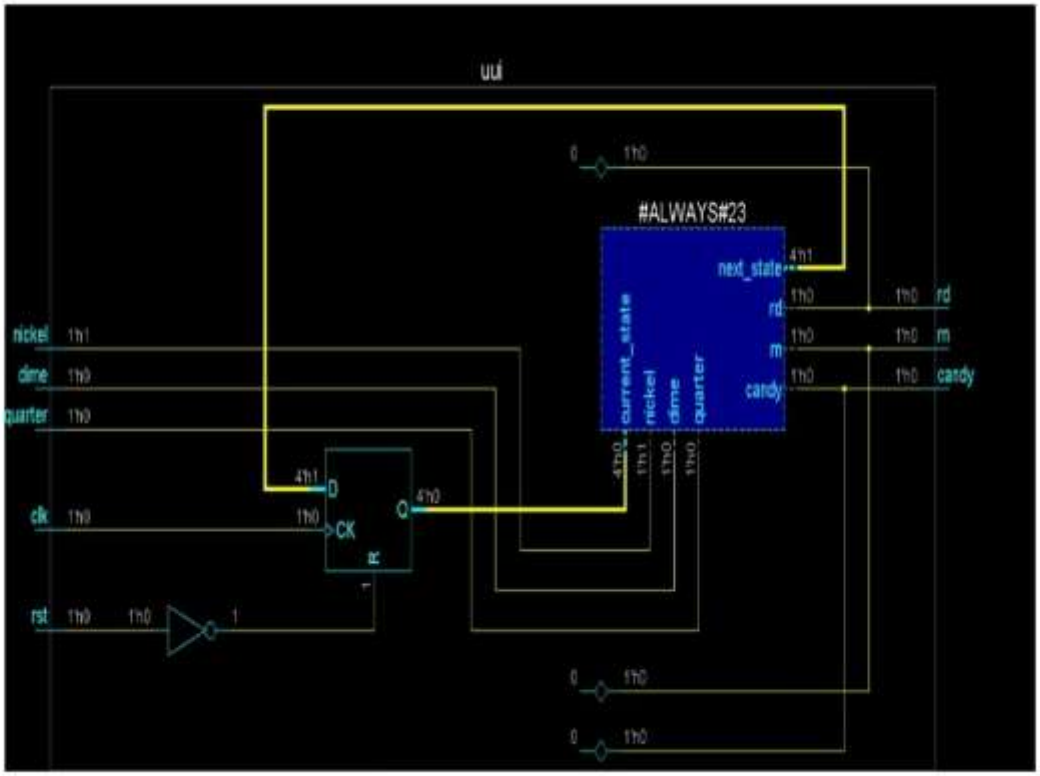


**Fig:2.internal architecture of candy vending machine**

AFinite State Machine (FSM) controller for a vending machine designed to dispense candy, illustrating a systematic process of coin handling and product dispensing. The machine begins in the "Start/Idle" state, waiting for the customer to insert a coin. Upon insertion, the system transitions to the "Insert Coin" state, where it processes the coin type—either a nickel (5 cents), dime (10 cents), or quarter (25 cents)—and moves to the corresponding state within the FSM controller. If the inserted coin is a nickel or dime, the machine may enter the "N/D" state, waiting for additional coins to accumulate the required 25 cents. When a quarter is directly inserted or the combined value of coins reaches or exceeds 25 cents, the system calculates the total amount and transitions to the next stage. If the total is equal to or greater than 25 cents, the machine moves to the "Candy" state and dispenses the candy; otherwise, it waits for further coins. In cases where the accumulated amount surpasses 25 cents, the system transitions to the "Change" state, dispensing the excess amount to the customer. After successfully delivering candy or returning change, the FSM proceeds to the "Reset" state, clearing the accumulated value and preparing for the next transaction. The cycle then repeats from the "Start/Idle" state, ensuring that the vending machine is always ready for new inputs. This FSM design efficiently handles coin insertion, value accumulation, candy dispensing, and change management in a streamlined and organized manner.

The given diagram represents a Finite State Machine (FSM) controller for a vending machine designed specifically to dispense candy, providing a structured and efficient approach to coin handling, value accumulation, candy dispensing, and change management. The vending machine's operation starts in the **"Start/Idle"** state, where it remains in a passive mode, waiting for the customer to insert a coin. This initial state signifies that the machine is powered on, operational, and ready to accept coins, but no transaction is currently in progress. Once a coin is inserted, the FSM transitions to the **"Insert Coin"** state, which acts as a central hub for determining the type of coin received. The machine is capable of accepting three types of coins: **nickels (5 cents)**, **dimes (10 cents)**, and **quarters (25 cents)**. Depending on the inserted coin, the system transitions

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to one of the specific states: **"Nickels"**, **"Dimes"**, or **"Quarters"**, which are part of the coin processing subsystem labeled **"FSMCONTROLLER"**.

When a **nickel** or **dime** is inserted, the system may enter the **"N/D"** state, which acts as an intermediate state where the accumulated value is calculated, and the machine waits for additional coins if the total is less than 25 cents. This state is crucial as it ensures the proper combination of lower-value coins to meet the cost requirement. On the other hand, if a **quarter** is inserted directly, the system bypasses intermediate accumulation states and moves towards evaluating whether the total amount has been satisfied. After every coin insertion, the FSM performs a calculation to determine the **total accumulated amount**. The system then checks whether the total value of the inserted coins meets or exceeds the minimum requirement of 25 cents.

If the total amount is **equal to or greater than 25 cents**, the FSM transitions to the **"Candy"** state, where the vending machine dispenses the candy to the customer. The direct transition to the candy dispensing state upon meeting the cost requirement ensures that the machine operates efficiently without unnecessary delays. However, if the accumulated amount is **less than 25 cents**, the machine remains in the intermediate state, prompting the customer to insert additional coins. An essential feature of the system is its ability to handle cases where the **total amount exceeds 25 cents**. In such scenarios, the FSM moves to the **"Change"** state, where the difference between the inserted amount and the cost of the candy is calculated, and the machine dispenses the appropriate change. This mechanism ensures that the customer always receives the correct balance, preventing overcharging and maintaining user satisfaction.

Once the candy is dispensed or change is returned, the system transitions to the **"Reset"** state, where it clears the accumulated value, resets internal variables, and prepares for the next transaction. This reset process is vital to ensure that no residual value from previous transactions affects subsequent operations. After resetting, the machine loops back to the **"Start/Idle"** state, completing the transaction cycle and indicating that the system is ready for the next customer. The **"Repeat"** transition from the reset state ensures that the machine continuously operates without requiring manual intervention between transactions.

## IV. Results and Analysis discussion

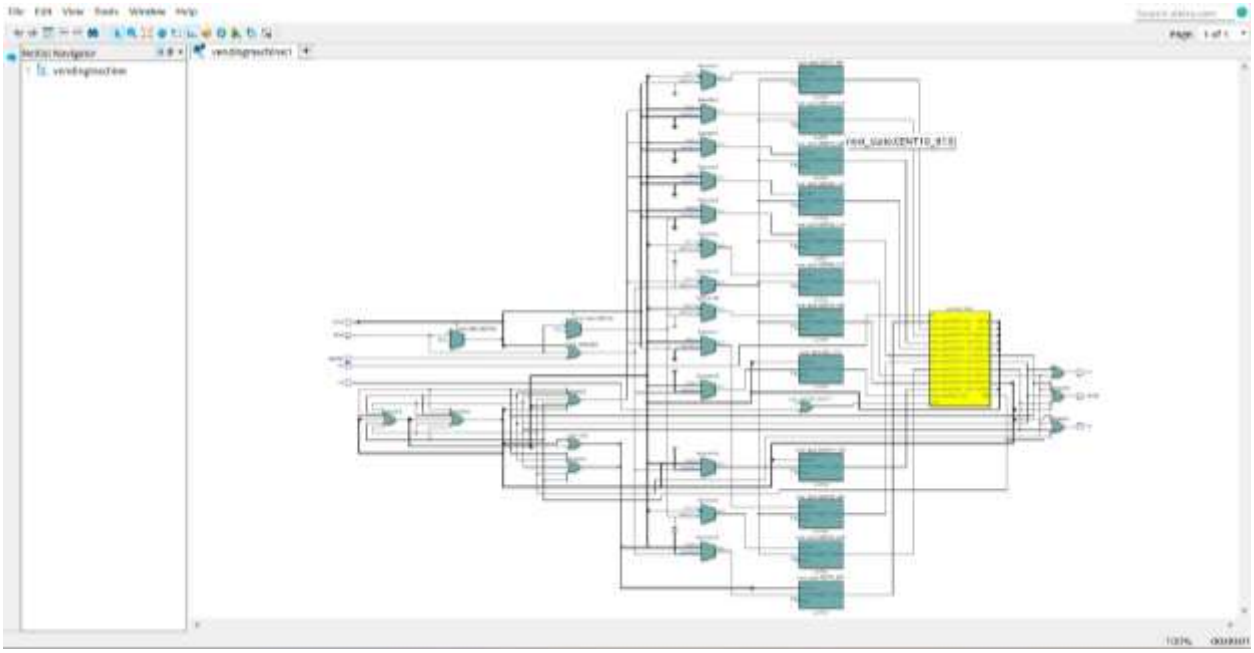

Fig.3. RTL schematic diagram.

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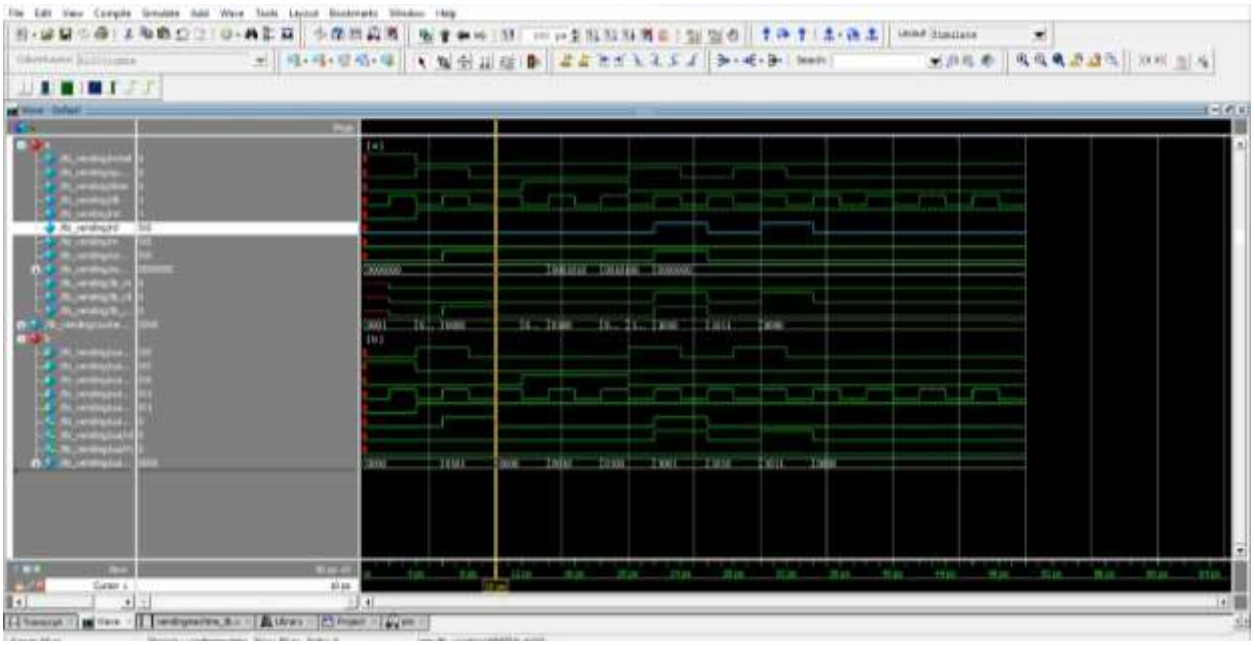

**FIG:4.WAVE FORM**

## V CONCLUSION

The design and implementation of an automatic candy vending machine offer a modern, efficient, and user-friendly solution for convenient candy distribution. By integrating advanced technology such as cashless payment systems, real-time inventory tracking, and energy-efficient operations, these machines enhance accessibility, reduce operational costs, and improve customer satisfaction.

Operating 24/7, vending machines provide round-the-clock service in high-traffic areas, ensuring seamless and quick transactions. T. Additionally, hygiene and safety considerations, such as touchless interfaces and sealed packaging, make these machines more appealing in the current market.

From a business perspective, automatic vending machines offer a cost-effective, low-maintenance solution with high revenue potential. Their compact design and strategic placement maximize sales while minimizing overhead costs. Energy-efficient features further enhance sustainability, making them an eco-friendly alternative to traditional retail.

Looking ahead, advancements in AI and blockchain technology can further optimize vending machine operations, providing personalized experiences and secure transactions. The successful implementation of this technology underscores its importance in modern retail, ensuring a reliable, profitable, and sustainable solution for the future of automated snack distribution.

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