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Design and Verification of Vending Machine using Verilog and System Verilog

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ABSTRACT: The vending machine is an automated machine that dispenses various products such as snacks, beverages, newspapers, tickets etc to customers when money or credit card is inserted. Vending machines are more accessible and practical than the convention purchasing method Now, vending machine market is a big business with huge annual revenue for leading nations like the USA, Japan, China and some other Asian countries including India. The paper aims to design a vending machine that can dispense three products of different prices with additional features of 'return change' when a coin of higher denomination is inserted and 'return money' when request is cancelled. The machine accepts coins of denominations five and ten. The finite state machine (FSM) approach is adopted for the design of vending machine. The design is achieved by formulating the Verilog code for the FSM-based machine using behavioural modeling and simulating the testbench for three products using Xilinx ISE tool.

KEYWORDS: Vending Machine, Finite State Machine, Behavioural model, CAD.

I. INTRODUCTION

The Vending Machine is an automatic machine that sells food such as canned soups and packaged sandwiches, snacks such as potato chips, chocolate bars, and candy); hot drinks (coffee, tea, and hot chocolate); cold drinks (juice, bottled water, soft drinks, and in some cases, milk or chocolate milk); or other items such as newspapers or tickets. The machines usually work when a product is selected and some money (usually coins or paper money) is put in a slot. Then, a button needs to be pushed, or a lever pulled. If there is enough money, the selected item will be dropped to a tray, where it can be taken out by the person making the purchase.

From 2000-2010, the specialization of vending machines became more common. Vending extended increasingly into non-traditional areas like electronics, or even artwork or short stories. Machines of this new category are generally called Automated retail kiosks. When using an automated retail machine, consumers select products, sometimes using a touch screen interface, pay for purchases using a credit or debit card and then the product is dispensed, sometimes via an internal robotic arm in the machine. The trend of specialization and proliferation of vending machines is perhaps most apparent in Japan where there is 1 vending machine for 23 people.

Apparently similar to the development of traditional mobile phones into smartphones, vending machines have also progressively, though at a much slower pace, evolved into smart vending machines. According to market research by Frost & Sullivan, global shipments of smart vending machines are forecasted to reach around 2 million units by 2018 and further to 3.6 million units by 2020 with penetration rate of 20.3 percent.

II. RELATED WORK

Various researches have been carried out in order to design the Vending Machines. A few of them are discussed below. In the paper, "FSM Based Design on the Replication of one-hot code using Verilog HDL[1]," a self-checking approach to enhance the SEU/MBUs immunity of FSMs' states by replicating One-Hot code times for state encoding is presented. This approach can correct less than bit-flip faults in the state register per cycle. Characteristics of this approach are obtained by this approach can offer more enhanced reliability than Binary or One-Hot state encoding, a self-checking approach to enhance the SEU/MBUs immunity of FSMs' states by replicating One-Hot code times for state encoding is presented. This approach can correct less than bit-flip faults in the state register per cycle.



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The paper “*Design and Implementation of Vending Machine using Verilog HDL on FPGA*” presents a Mealy machine–based vending machine model implemented on a Spartan-3 FPGA board, verified using Xilinx 9.2i and Modelsim 6.2a, and compared with earlier designs in terms of timing and device utilization, highlighting scope for future improvements. Similarly, “*Finite State Machine based Vending Machine Controller with Auto-Billing Features*” models a four-state process—user selection, money insertion, product delivery, and servicing—using a Mealy machine, tested on Spartan-3 and benchmarked against CMOS-based machines. Meanwhile, “*Design and Implementation of Vending Machine using Verilog HDL*” proposes a simple FPGA-based vending machine offering four products (ice cream, Coca-Cola, snacks, chocolate), accepting one- and two-rupee coins, providing change, and including a cancel option, with simulation carried out using Xilinx State CAD tools. Together, these works emphasize FSM-based modeling, FPGA implementation, and practical enhancements like auto-billing, change return, and efficiency improvements in vending machine design.

III. METHODOLOGY

The methodology for designing a vending machine using Verilog and SystemVerilog involves a structured hardware description approach that models the machine’s functionality through modular design and finite state machines (FSMs). The process begins with requirement analysis, where the operational flow of the vending machine is defined, including product selection, payment validation, dispensing, and change return. Based on these requirements, the system is divided into functional modules such as the input interface (keypad for product selection and coin acceptor signals), the control unit (FSM for managing states), the output interface (LCD or seven-segment display for transaction details), and the actuator driver (motor control for product dispensing).

The figure illustrates the logical flow of operations in a vending machine, starting from the initial state and progressing through product selection, payment, and dispensing. The process begins with the Start node, where the user selects a product. Once a product is chosen, the system prompts the user to insert coins, and the machine increments its internal count of the inserted money. At this stage, the user has the option to cancel the transaction; if cancellation occurs, the machine returns the money and decrements the count, ending the process. If the user does not cancel, the system checks if the inserted money is equal to the product price. If yes, the machine gives the product and decrements the count. If the money is greater than the price, the machine gives the product and change, then decrements the count, and loops back to the 'Insert coins' step. If the money is less than the price, the process ends at the 'Stop' node.

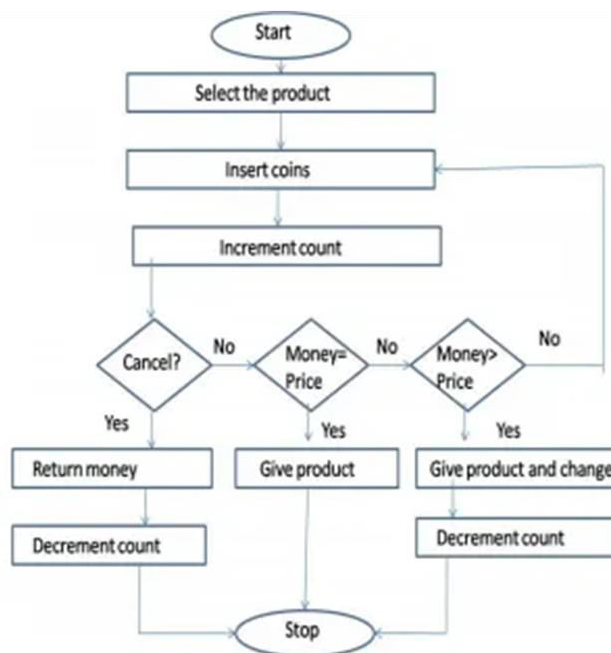
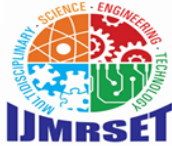


Figure: Flowchart of a Vending Machine



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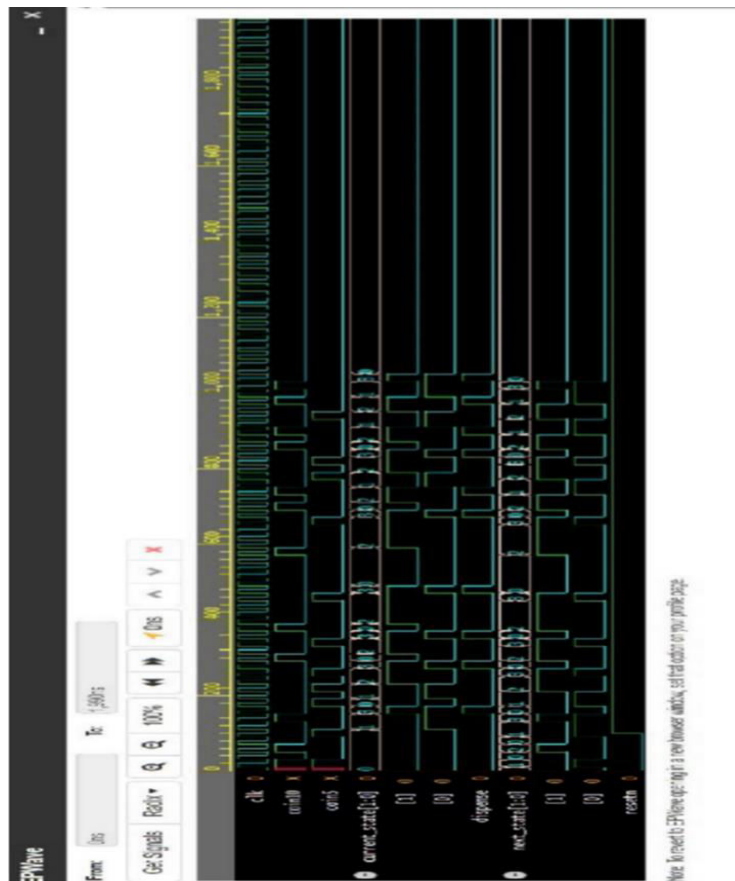
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If the transaction continues, the machine checks whether the **money equals the product price**. If the condition is satisfied, the product is dispensed and the process stops. If the money exceeds the price, the machine dispenses the product along with the appropriate **change**, decrements the product count, and then stops. If the money is less than the price, the system loops back to the **insert coins** step, allowing the user to add more payment until the required amount is reached.

Overall, the figure demonstrates a clear decision-making structure that ensures accurate product dispensing, proper handling of cancellations, and correct return of change, reflecting the finite state machine methodology used in vending machine design.

IV. EXPERIMENTAL RESULTS

The vending machine system provides real-time transaction management such as product selection, payment validation, dispensing, and change return using Verilog and SystemVerilog, with the design implemented and simulated on EDA Playground using Synopsys VCS to ensure accurate modeling and verification of the finite state machine (FSM). The FSM transitions through states like Idle, Selection, Payment, Dispense, and Return Change, enabling smooth and deterministic operation.



.Figure: Simulation Results

The waveform verifies correct FSM behavior:

- Proper state transitions
- Correct output generation
- Synchronization with clock
- Reset functionality working



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V. CONCLUSION

The vending machine controller designed using Verilog and SystemVerilog provides a robust and efficient solution for automating product dispensing based on user input and payment validation. By modeling the system as a finite state machine (FSM), the design ensures clear state transitions, reliable operation, and easy debugging. The modular architecture allows seamless integration of coin detection, product selection, and change return mechanisms, making the system scalable for different vending machine configurations.

Simulation results confirm that the controller performs accurately under various input conditions, demonstrating the effectiveness of hardware description languages in real-time digital system design. The use of Verilog/SystemVerilog not only simplifies implementation but also enables synthesis on FPGAs for practical deployment. While the current design meets functional requirements, future improvements could focus on enhancing fault tolerance, supporting multiple payment methods, and integrating IoT-based monitoring for remote management.

REFERENCES

- [1] A. K. Sharma, R. Gupta, and S. Verma, "Design and Implementation of Automatic Vending Machine using Verilog HDL," International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 6, pp. 123–126, 2020.
- [2] P. Ashenden, The Designer's Guide to Verilog HDL, Morgan Kaufmann, 2008.
- [3] M. M. Mano and M. D. Ciletti, Digital Design with an Introduction to Verilog HDL, 6th ed., Pearson, 2017.
- [4] "Modeling and Simulation of Vending Machine using SystemVerilog," International Journal of Computer Applications, vol. 178, no. 40, pp. 20–25, 2021.
- [5] "Design of FPGA-Based Vending Machine Controller using Verilog HDL," International Conference on Electronics and Communication Systems (ICECS), 2018.
- [6] Ana Monga, Balwinder Singh, "Finite State Machine based Vending Machine Controller with Auto-billing Features," International Journal of VLSI Design and Communication Systems, Vol.3, No.2, April, 2012.
- [7] Ashwag Alrehily, Ruquiah Fallatah, Vijey Thayananthan, "Design of Vending Machine using Finite State Machine and Visual Automata Simulator," International Journal of Computer Applications, Vol.115, No.18, April, 2015.
- [8] B. Jyothi, I. Sarah, A. Srinivas, "Implementation of FPGA based Smart Vending Machine," International Journal of Engineering Research and Applications, National Conference on Engineering Developments, Advances and Trends, January, 2015.
- [9] Chexel D. Augustin, Sarah Grace P. De Castro, Paul Jonathan B. Dimaano, Sarah Dyan S. Garraton, Rionel Belen Caldo, "Password Protected Vending Machine with Moore Finite State Machines using Verilog," Laguana Journal of Engineering and Computer Sciences, Vol.3, No.2, March 2016.
- [10] Ritika Kalihari, Toran Verma, Alka Jaiswal, "Concept of Automated Machine using Mealy," International Journal of Computer Applications Technology and Research, Vol.2, Issue-3, pp.335-339, 2013



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