Implementation of FSM Based Smart Vending Machine using Verilog HDL

[1]P.Rajesh, [2]P.Jahnavi Sathakarni, [3]A.Kusuma, [4] P.Nageswara Rao

[1]Assistant Professor, [2, 3, 4] UG Students

[1,2,3,4] Department of ECE, Annamacharya Institute of Technology & Science [Autonomous], Tirupati, Andhra Pradesh, India.

Abstract: **The central idea of this work is to design a vending machine that will be able to provide a number of items like soft drink, cake & coldrinks to people. The machine will also deliver the change, depending on the amount of money inserted and the price of product. At the same time we have made efforts to make the design of the Vending Machine power efficient by using power reduction techniques. In this process we have tested our design at different frequencies and analyzed the consumed power. The proposed design is tested and implemented using VERILOG HDL and XILINX ISE 14.2.**

Index Terms **– Vending machine, FSM, Verilog HDL.**

1. INTRODUCTION

Vending Machines are used to dispense various products like Coffee, Snacks, and Cold Drink etc. when money is inserted into it. Vending Machines have been in existence since 1880s. The first commercial coin operated machine was introduced in London and England used for selling post cards. The vending machines are more accessible and practical than the convention purchasing method. Nowadays, these can be found everywhere like at railway stations selling train tickets, in schools and offices vending drinks and snacks , in banks as ATM machine and provides even diamonds and platinum jewelers to customers. Previous CMOS and SED based machines are more time consuming than the FPGA based machines. The FPGA based machine is also more flexible, programmable and can be reprogrammed. But in microcontroller based machine, if one wants to enhance the design, he has to change the whole architecture again but in FPGA user can easily increase the number of products. In this paper a novel approach is proposed to design a Vending Machine with auto-billing features. The machine also supports a cancel feature means that the person can withdraw the request and the money will be returned back to the user. This machine can be used at various places like Hotels, Restaurants and food streets. This reduces the time and cost. The machines usually work, when 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 in the machine, the selected item will be dropped to a tray, where it can be taken out by the person making the purchase. Older vending machines were mechanical, but most new ones are electronic. Many modern vending machines can accept debit or credit cards in addition to cash. Some products need to be prepared to become available. For example, tickets are printed or magnetized on the spot, and coffee is freshly concocted. One of the most common form of vending machine, the snack machine, often uses a metal coil which when ordered rotates to release the product. In the Western world, some vending machines dispense personal products, typically in public toilet facilities. The machines in ladies' restrooms typically sell pads or tampons. The machines in men's rooms, when they are present, are most commonly for the sale of condoms, though in some locations they maybe found dispensing cologne, medicine, small candies, or even pornography. These are often found at toilets used by transient persons in high traffic locations, such as bus station.

1.1 Operation of Vending Machine

- When the user puts in money, money counter tells the control unit, the amount of money inserted in the Vending Machine.
- When the user presses the button to purchase the item that he wants, the control unit turns on the motor and dispenses the product if correct amount is inserted.
- If there is any change, machine will return it to the user.

- The machine will demand for servicing when the products are not available inside the machine.

1.2 FSM (Finite State Machine) [2] [3]

In a Finite State Machine the circuit's output is defined in a different set of states i.e. each output is a state. A State Register to hold the state of the machine and a next state logic to decode the next state. An output register defines the output of the machine.

In FSM based machines the hardware gets reduced as in this the whole algorithm can be explained in one process.

Two types of State machines are:

- MEALY Machine
- MOORE Machine

MEALY Machine: In this machine model, the output depends on the present state as well as on the input. The MEALY machine model is shown in figure 1. Figure 1:

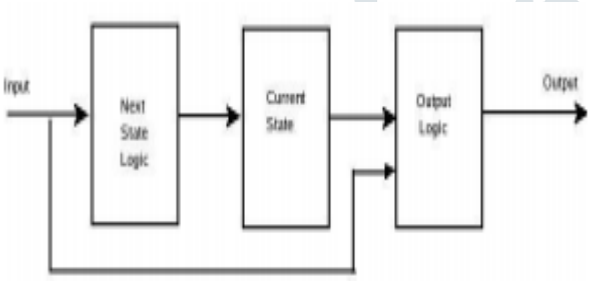


Fig. 1: MEALY Machine Model

MOORE Machine: In Moore machine model the output only depends on the present state. The MOORE machine model is shown in figure 2.

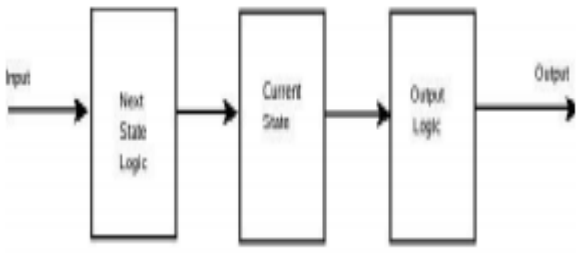


Fig. 2: MOORE Machine Model

This paper is organized as section II describes Existing System and in section II discussed Proposed Method and Section IV describes in Simulation results and Section V concludes the paper followed by references.

2. RELATED WORK

Various researches have been carried out in order to design the Vending Machines. A few of them are discussed here as: Fauziah Zainuddin [1] proposes a vending machine for steaming frozen food using conceptual modelling. In which the process of three main states (user selection state, freezer state and steaming state) has been modelled using process approach, which emphasized on the process flow or control logic to construct the model for steamed buns vending machine application.

Conceptual modelling is described in [6]. In [4] the concept of automatic mobile payment is discussed. This concept is based on the short message payment with the main control module M68HC11 and GPRS module MC35. Thee various methods of designing VHDL based machines are discussed in [2], [3] and [9]. Also in [5] the passenger's requirements for ticketing system are given. In [7] a coffee vending machine is designed using single electron encoded logic (SEEL). The designed circuit is tested and its power and switching time is compared with the CMOS technology.

3. IMPLEMENTATION OF VENDING MACHINE

In this paper a state diagram is constructed for the proposed machine which can vend four products that is candy, cake, cold drink.

The user first selects the item he wants to purchase. Then the user inserts the money. If the money inserted in the machine matches to that of the product selected then the product is dispensed as the output. If there is any change left it is given back to the user,. In my vending machine there are only 3 types of product with their process given below in Table 1.

TABLE I. PRODUCTS WITH PRICE OF VENDING MACHINE

S.No.	Product	Price
1	Candy	5
2	Cake	10
3	Coldrink	15

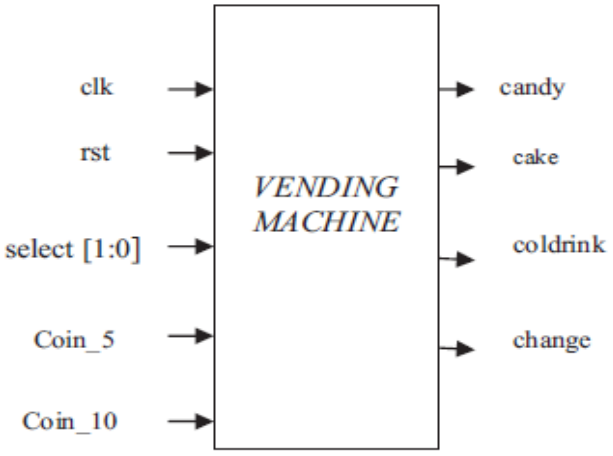


Fig.3: Block diagram of Vending Machine

From the figure 3 it is clear that the vending machine only accepts two types of coins i.e coin_5(for a 5 rupee coin) and coin_10 (for a 10 rupees coin).four types of select bit are also present for the user i.e

i. S_0: initially it will be present in idle state or reset state.
ii. S_1 (2'b01): for the selection of product candy.
iii. S_2 (2'b10): for the selection of product cake.
iv. S_3 (2'b11): for the selection of product coldrink.

Vending machine has also five intermediate states

1. st_0 (if it is in state Zero)
2. st_5 (if it is in state Five)
3. st_10 (if it is in state Ten)
4. st_15 (if it is in state fifteen)

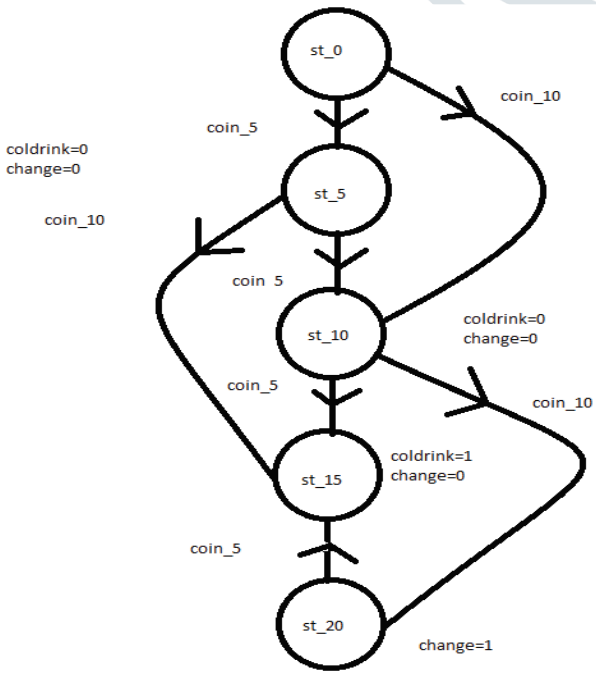


Fig.4 FSM for Coldrink

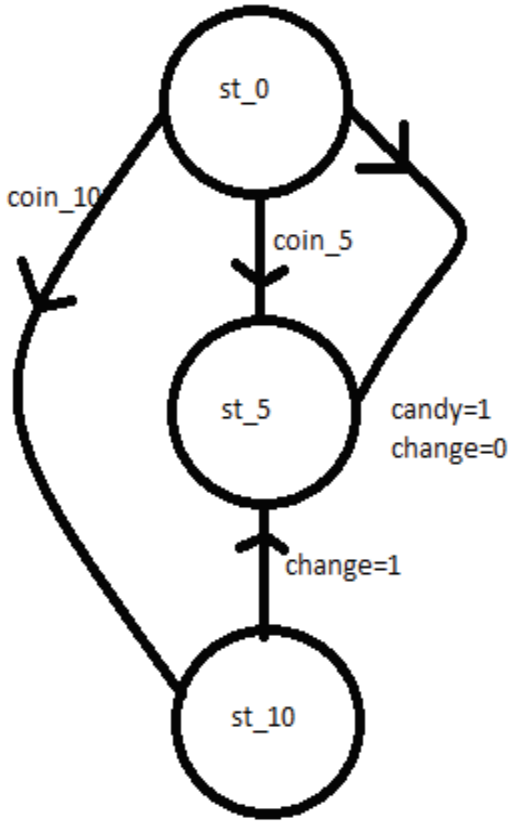


Fig.5 FSM for Candy

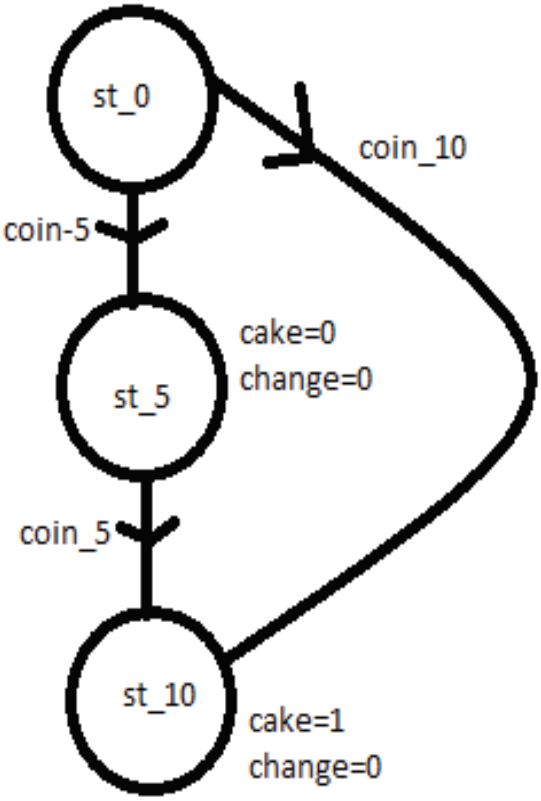
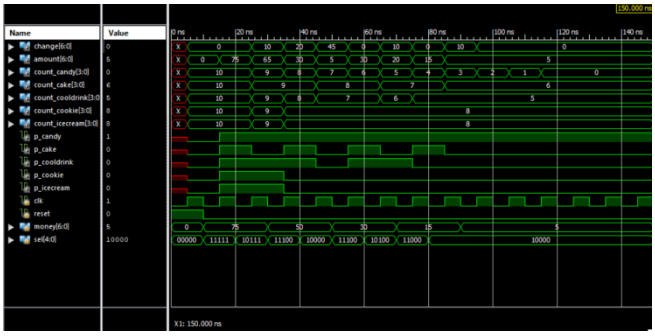


Fig.6 FSM for Cake

4. SIMULATION RESULTS



The state diagram shown in figure 4,5 and 6 is simulated using Xilinx ISE Simulator. Simulation Waveforms for the selection of Three products like coldrink ,candy and cake is shown in figure 4, 5 and 6 respectively with servicing feature when products are not available in the machine and change return features when the money inserted is more than the money of the product

5. CONCLUSION

When we realized that we have at last made a code that could actually work as a user friendly vending machine. This code can actually provide a variety of options to the user and also return him/her the balance money. This verilog code has been successfully verified using the Xilinx ISE tool and the desired outputs have been achieved. Vending Systems enhances productivity, reduces system development cost, and accelerates time to market.

Vending machine gives fast response and is easy to use by an ordinary person. The designed machine can be used for many applications and we can easily enhance the number of selections. The next stage of this study is to convert this model into hardware and to calculate the total power consumption of the machine. Thus we would conclude saying that we tried our bit to modify the present day complex vending machine into a user friendly and user specific vending machine.

REFERENCES

1. S Mishra and G. Verma, "Low Power and Area Efficient Implementation of BCD Adder on FPGA", *International Conference on Signal Processing and Communication (ICSC-2013);*, pp. 461-5, 2013 Dec 12–14.
2. Gaurav Verma, Shambhavi Mishra, Sakshi Aggarwal, Surabhi Singh, Sushant Shekhar and Sukhbani Kaur Virdi, "Power Consumption Analysis of BCD Adder using XPower Analyzer on VIRTEX FPGA", *Indian Journal of Science and Technology*, vol. 8, no. 18, pp. IPL0160, August 2015.
3. *Xilinx Inc. Spartan 3 Data sheet*, [online] Available: http://www.xilinx.com.
4. [online] Available: http://www.xilinx.com/support/documentation/user_guides/ug47l_7Series_SelectIO.pdf.
5. *Verilog HDL by Samir Palnitkar*.
6. *FPGA Prototyping by Verilog examples by PONG P.CHU*.
7. *Ana Monga Balwinder Singh FSM Based vending machine controller with Auto billing features*.
8. [online] Available: http://www.tutorial-reports.com/computer-science/fpga/overview.php.
9. [online] Available: http://www.slideshare.net/sanjivmalik/fpgas-an-overview.
10. Show Context
11. T. Gupta, G. Verma, A. Kaur, B. Pandey, A. Singh and T. Kaur, "Energy Efficient Counter Design Using Voltage Scaling On FPGA", *International Conference on Communication Systems and Network Technologies (CSNT-2015)*, April 4–6, 2015.
12. S. Aggarwal, G. Verma, R. Kumar, A. Kaur, B. Pandey, S. Singh, et al., "Green ECG Mac
13. hine Design Using Different Logic Families", *International Conference on Communication Systems and Network Technologies (CSNT-2015)*, April 4–6, 2015.
14. T. Gupta and G. Verma, "Area & Power Optimization of VPB Peripheral Memory for ARM7TDMI Based Microcontrollers", *International Conference on Cognitive Computing and Information Processing (CCIP-2015)*, March 3–4, 2015.
15. G. Verma, A. Moudgil, K. Garg and B. Pandey, "Thermal and Power Aware Internet of Things Enable RAM Design on FPGA", *International Conference on Computing for Sustainable*
16. Shivani Madhok, Gaurav Verma, Ankur Bhardwaj, Himanshu Verma, Ipsita Singh and Sushant Shekhar, "Capacitance Scaling With Different IO Standard Based Energy Efficient Bio-Medical Wrist Watch Design on 28nm FGPA", *International Journal of Bio-Science and Bio-Technology*, vol. 7, no. 4, August 2015.