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Finite State Machine based Vending Machine using VHDL

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Abstract— Nowadays, Vending Machines are well known among Japan, Malaysia and Singapore. The quantity of machines in these countries is on the top worldwide. This is due to the modern lifestyles which require fast food processing with high quality. This paper describes the modeling of a Finite State based vending machine using the mealy machine model. The proposed machine has been implemented on Spartan3 FPGA development board. The advantages of using this machine have been indicated in the paper. The whole design has been functionally verified using Xilinx 9.2i and Modelsim 6.2a simulator. A vending machine is a machine which dispenses items such as snacks, beverages, lottery tickets, consumer products to customers automatically after the customer inserts currency or credit into the machine. This paper compares different aspects as timing and device utilization of the proposed machine with the previously proposed machine3. Also the paper indicates a future possibility of a betterment over existing vending machines.

Keywords— *Vending Machines, FPGA, Verilog, Xillinx ISE simulator, Modelsim, FSM.*

I. 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 jewellers 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 re-programmed. 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 project a new approach is proposed to design an FSM based Vending Machine. 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. The user will get a bill of total number of products delivered with total price. This machine can be used at various places like Hotels, Restaurants and food streets. This reduces the time and cost.

II. RELATED BACKGROUND

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.

III. IMPLEMENTATION OF VENDING MACHINE

In this paper a state diagram is constructed for the proposed machine which can vend four products that is coffee, cold drink, candies and snacks. Four select (select1, select2, select3, select4) inputs are taken for selection of products. Select1 is used for the selection of snacks. Similarly select2, select3, select4 are used for coffee, cold drink and candies respectively. Rs_10 and rs_20 inputs represents rupees 10/- and 20/- notes respectively. A cancel input is also used when the user wants to withdraw his request and also the money will be returned through the return output. Return, product and change are the outputs. Return and change vectors are one bits wide. Money is an in/out signal which can be updated with the total money of all products delivered at a time. Money signal is seven bits wide. Money_count is an internal signal which can be updated at every transition. This signal is also one bits wide. If the inserted money is more than the total money of products then the change will be returned through the change output signal. The products with their prices are shown by table 1. There are also two input signal clk and reset. The machine will work on the positive edge of clock and will return to its initial state when reset button is pressed. The proposed vending machine is designed using FSM modelling and is coded in VHDL language. The detail of the entire

signal with their direction and description is shown in table 2.

Table 1: Products with their prices

S. No.	Product	Price
1	Snacks	30
2	Coffee	40
3	Cold Drink	40
4	Candy	30

Table 2: Inputs/Outputs with Remarks

Name	Width	Direction	Description
Clk	1	INPUT	Clock
Reset	1	INPUT	Syn reset
In1	1	INPUT	1 rupee coin
In2	1	INPUT	2 rupee coin
In5	1	INPUT	5 rupee coin
LOAD	1	INPUT	load
Out1	1	OUT	1 rs change
Out2	1	OUT	2 rs change
Out5	1	OUT	5 rs change
FDIS	1	OUT	Final Product

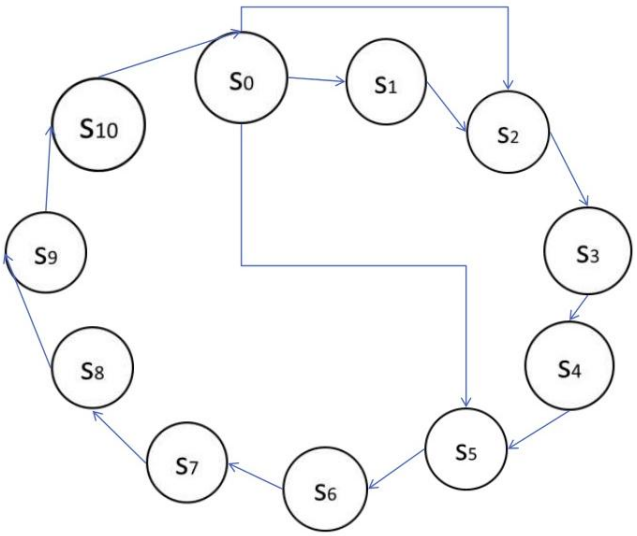

Figure 1 State Diagram of Vending Machine

IV. DESIGN METHODOLOGY

The state diagram mainly consists of four states (User Selection, Waiting for the money insertion, product deliveryand servicing (when product_not_available='1')). Initially when the reset button is pressed, the machine will be ready for the users to select the product. This state is the initial state of the design. After this the user will select the product to be dispensed. This state can be one of the select1, select2, select3 and select 4. The machine can accept only two types of notes i.e. rupees 10/- and 20/-. Let us suppose that the user selects sel1 input. The machine will firstly check that whether the products are available in the machine or not. After this the control unit will move to the waiting state, where it will wait for the money to be inserted. Then if rupees 10/- note is inserted then the machine will go to state_1 and wait until the desired money is inserted. And if rupees 20/- note is inserted the machine will move to state_2 and then wait until 30/- rupees are inserted to the machine. When the desired amount is inserted the machine will go to the snacks state and snacks will be delivered at the product output. If products are not available in the machine then the control unit will demand for servicing and after service the machine will get reset. This methodology is explained using a flow diagram shown in figure 2.

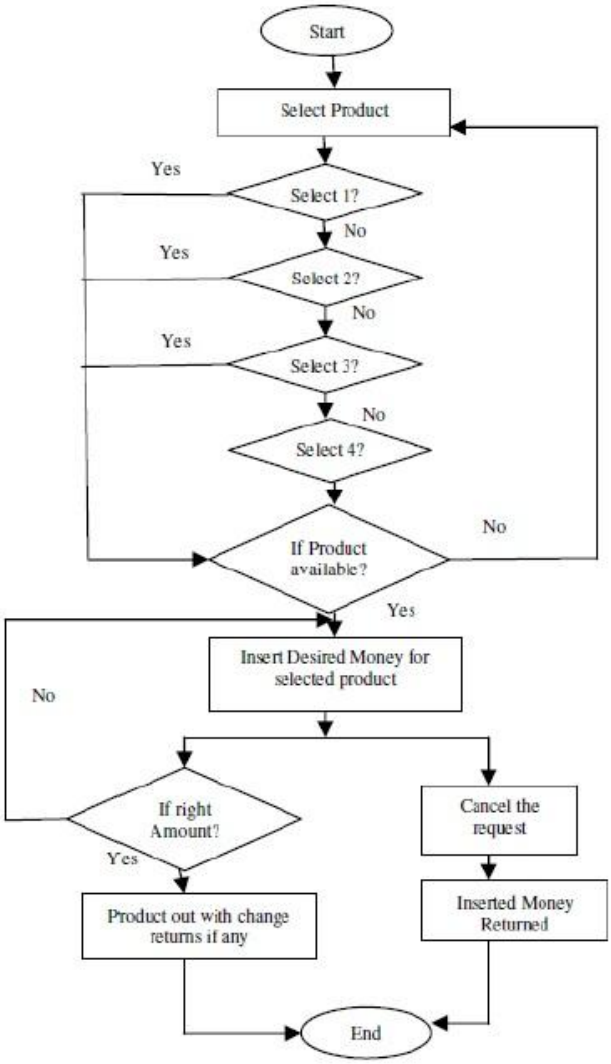

Figure 2 Flow Diagram of Vending Machine

V. SIMULATION RESULTS

The state diagram shown in figure 4 is simulated using Xilinx ISE Simulator. Simulation Waveforms for the selection of four products like snacks is shown in figure 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. Let us take an example that the user wants to take Snacks. When one selects sel1 button, the machine will check that whether the products are available or not, if

available then it will go to the waiting state and wait for total money insertion. If rs_10 note is inserted it will go to state_1 and if rs_20 note is inserted it will so to state_2 and check whether money_count>=30 or not. If the money_count >- 30 then machine will go to state snacks and vend the product.

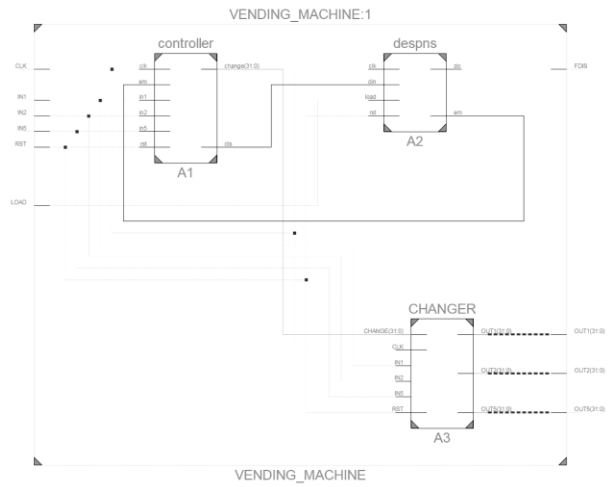

Figure 3 Vending Machine Design flow

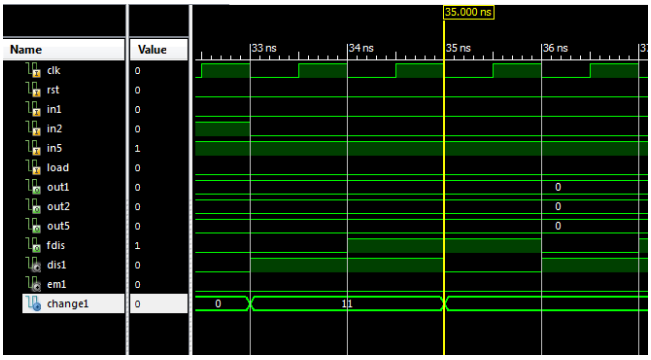

Figure 4 Simulation waveform

VI. 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 9.2i 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.

VII. REFERENCES

[1] Fauziah Zainuddin, Norlin Mohd Ali, Roslina Mohd Sidek, Awanis Romli, Nooryati Talib & Mohd. Izham Ibrahim (2009) "Conceptual Modeling for Simulation: Steaming frozen Food Processing in Vending Machine" International Conference on Computer Science and Information Technology, University Malaysia Pahang, pp.145-149.

[2] Zhang Wen & Zhang Xin Long (2010) "Design and Implementation of automatic vending machine Based on the short massage payment" International Conference on Information and Communication technology in Electrical Sciences, Neijiang, Sichuan, China.pp.978-981.

[3] B. Caulfield & M.O Mahony (2005) "Passenger Requirements of a Public Transport Ticketing System" Proceedings of the 8th International IEEE Conference on Intelligent Transportation Systems Vienna, Austria, pp-32-37.

[4] M. Zhou, Q. Zhang & Z. Chen (2006), "What Can Be Done to Automate Conceptual Simulation Modelling?" Proceedings of the 2006 Winter Simulation Conference, pp. 809 – 814.

[5] Biplab Roy & Biswarup Mukherjee (2010) "Design of Coffee Vending Machine using Single Electron Devices" Proceedings of 2010 International Symposium on Electronic System Design. Pp 38-43.

[6] C. J Clement Singh, K Senthil Kumar, Jayanto Gope, Suman Basu & Subir Kumar Sarkar (2007) " Single Electron Device based Automatic Tea Vending Machine" proceedings of International Conference on Information and Communication Technology in Electrical Sciences (ICTES 2007) , pp 891-896.

[7] P. Smith (1997) "Automatic Hot-food Vending Machine," Trends in Food Science & Technology October 1997, Vol. 81, and pp. 349.

[8] M. Zhou, Y. J. Son, & Z. Chen, (2004), "Knowledge Representation for Conceptual Simulation Modeling" Proceedings of the 2004 Winter Simulation Conference, pp. 450 – 458.

[9] Muhammad Ali Qureshi, Abdul Aziz & Hafiz Faiz Rasool "Design and Implementation of Automatic Ticket System using Verilog HDL" proceedings of tnternational conference on Information Technology, pp- 707-712.

[10] Steve Kilts," Advanced FPGA Design: Architecture, Implementation, and optimization", Wiley-IEEE press, 2007.

[11] Seyed Bahram Zahir Azami & Mohammad Tanabian "Automatic Mobile Payment on a non- Connected Vending Machine" proceedings of Canadian Conference on Electrical and Computer Engineering, 2004, pp- 731-734.