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Implementation of Vending Machine through Verilog HDL

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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 designing of multi select machine using Finite State Machine Model with Auto-Billing Features. Finite State Machine (FSM) modeling is the most crucial part in developing proposed model as this reduces the hardware. In this paper the process of four state (user Selection, waiting for money insertion, product delivery and servicing) has been modeled using MEALY Machine Model. The proposed model is tested using Spartan 3 development board and its performance is compared with CMOS based machine. In this work a kind of vending machine system for coffee and hot drinks is proposed. On this basis the applied architecture and control algorithm are presented and described. The developed modules for control are successfully implemented and testing using the hardware description language Verilog HDL. Some simulation results are illustrated and analyzed. The results obtained from the research can be used in the practical implementation of the considered vending machines.
Keywords: vending machine, development kit, Verilog HDL.

1. INTRODUCTION

The vending machines are widely used in the modern world. They offer the opportunity to choose and purchase different types of products like snacks, drinks, chewing gum, sweets, coffee etc. that can be placed inside or prepared on site by the machine itself for a fee. In recent years, companies have introduced vending machines that supply other products, such as electronic products, digital cameras or iPods. Product selection is usually done by pressing physical or capacitive buttons. The buttons can be in a configuration (one to one) or a keyboard configuration where a different combination of buttons corresponds to a different product [1-3]. Payment at vending machines is traditionally made by placing coins in a slot, but nowadays there are conversions that also use banknotes and card payments. Different types for controls of vending machines have been synthesized, implemented, tested and analyzed in [2-7]. The main advantages of vending machines can be formulated as follows [1-5]: – provide customers with the opportunity to make a free choice to purchase products at any time of day and year; – a great variety of products that the vending machine can provide, such as fruit, beer, beverages and cigarettes; – low cost due to

lack of staff; – the machine can always be moved to another location and will continue to deliver products. The main disadvantage is related to the production of the vending machine can cost a lot of money. Controls of various objects through FPGA and CPLDs using the hardware description languages like Verilog HDL and VHDL are synthesized, implemented and simulated in [8- 12]. This article focuses on a vending machine for coffee and hot drinks prepared at the moment. The developed control through the language hardware description language VerilogHDL refers to a vending machine that offers five drinks that can be selected via buttons in the configuration one to one. The way in which the payment is made in the machine is through coins. The maximum price of a product from the machine is limited to a certain value. Some simulation results are demonstrated and discussed.

2. LITERATURE REVIEW

Vending Machine Technologies by N. Ratnasri and T. Sharmilan-Vending Machines are automated machines that dispense selling products such as snacks, beverages, lottery tickets, and etc. It is vital to save time and reduce human energy. These vending machines are developed in the way of Non IoT-based and IoT based methods. These Non IoT based machines are not smart and are not operated in real-time data, which are functioned when giving cash or card and inputs (vending things) of the machine. It is controlled by a microcontroller and distributed the given inputs. IoT-based machines are computerized, which have cashless payment facilities, order facility before going to the vending machine to order things, and can be identified the location of machines by the customer. These IoT-based machines are assisted by suppliers to identify the availability of the stocks. Simulation software and prototype are used to validate the machines. In this review, it is found that most of the vending machines developed are capable of operating without IoT technology, and nowadays, vending machine systems are required to implement using IoT with machine learning, and artificial technologies to satisfy customer preferences.

Design of a vending machine control system, In Applied Mechanics and Materials by HY Yang and XM Zhu-Vending machines are available in many public places for vending of items like snacks, beverages, newspapers, tickets and smoking cigarettes Recently developed vending machine requires a control system to offer a variety of products to the general public. In this light, this paper, therefore, is aimed at developing a control system for the developed vending machine by developing various inputs required to make the machine function efficiently. The system controls and monitors the vending machine functions, namely: alarm system, product dispensing, refrigeration and payment system. The microcomputer capitalizes on the evolution of high-performance processors and stable operating systems to implement control requirements. The project shall use intelligent vending machine input/output board to link other machine peripherals. The control system shall enable the machine to handle coin, mobile and point of sale terminal payment options. Implementation of the control system enhances flexibility in payment, remote machine monitoring and inventory control, and improved user experience through the integration of digital touch screen user interfaces and high-speed transaction processing.

Design of Vending Machine using Verilog HDL by A. Krishna Kumar, G. Ashritha and D. Deepika-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.

3.PROPOSED SYSTEM

The hardware part is very important for the development of the vending machine, as it depends on many of the parameters and limits that must be complied with by the logic modules.

The vending machine consists of the following basic elements:

• Beverage selection buttons (five pieces).

• Buttons to increase and decrease the amount of sugar (two pieces).

• LED for light indication of the amount of sugar (five pieces).

• Module "Coin_initialization" is used for acceptance or rejection of coins. This module identifies the deposited coin and places it in a waiting area. If it is identified as one of the supported coins, a single pulse is applied. In case of unsuccessful identification, the coin is rejected and single pulse is no given.

• Module "Storage and dispensing" – these modules are used for the products like coffee, milk, sugar and cocoa respectively. The modules consist of a container and a screw pump with design which is defined in [13]. The control of this module consists of giving a signal for dispensing, as the dispensed quantity depends only on the time during which the signal is active.

• Module "Hot water dispensing" dispenses hot water (90) in the mixer. A single dispensing signal is used to control this module, and the amount dispensed depends only on the time for which the signal is active.

• "Mixer" is device in which all concentrates are mixed and diluted with warm water. This device uses an electronically controlled tap.

• Device for dispensing coffee cups - by design and specification described in [14].

• The module "Coin" is used to dispense a single coin of the type. It has a sensor provision for each slot, which allows checking for the presence of one or more coins. The outputs of the module "Coin" are connected to the FPGA chip for monitoring for the presence of one or more coins in each slot. The inputs of the module are respectively the control effects of the mechanism for dispensing.

During the development of the control system, a modular architecture is applied, which allows the logic blocks to be implemented independently of each other. This gives opportunities for the improvement of each individual module without having to change the other ones.

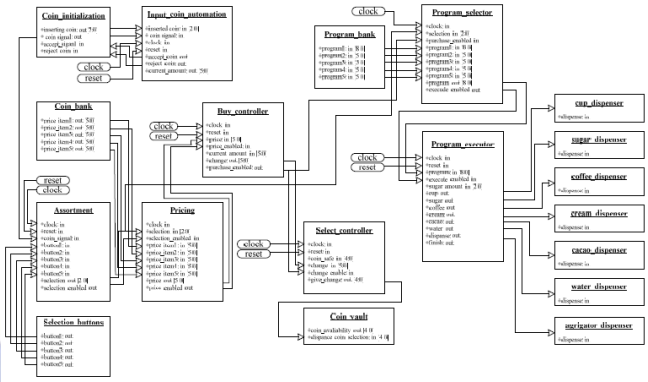

Figure 1: A block diagram of the implemented vending system.

The simplified block diagram of the implemented vending machine is shown in Figure 1. The developed modules for control are as follows:Assortment, Coin_bank,Input_coin_automation, Select_controller, Buy_controller, Program_selector, Program_executor, Pricing.The coins are to simplify the operation of the machine are presented in tokens. The modules from the block diagram that are not marked as <hardware> will be implemented additionally in the FPGA chip, as well a several additional auxiliary modules.The module "Assortment" processes the information coming from the beverage selection buttons. When a button is actually pressed, the output is activated as a binary number on the module bus and uses signal selection_enabled to the other modules that the value in the module "Assortment" is valid. The signal selection_enabled must remain active at all times during which the selection is valid. When placing a coin in the vending machine, the selection_enabled signal is switched off so that the user can select the desired beverage.The module "Pricing" uses the incoming signal selection to determine the price of the selected beverage. The prices of each of the drinks come as inputs to the module. When the correct price is set, the module checks whether the signal selection_enabled is activated. The signal price_enabled must always be off when the signal selection_enabled is deactivated. The module "Coin_bank" is a memory module that stores the price values of each beverage.

The module "Input_coin_automation" is a finite state machine, which upon receipt of a coin accepts its index and moves the state accordingly.The module "Buy_controller" is used to control and verify purchases, accepting the amount accumulated so far and the price

of the drink. At the initial moment, it is assumed that a successful purchase has been made in the machine and the signal purchase_enable remains active.The module "Select_controller" accepts the value of the change that must be returned by the machine and controls the coin of the machine, successively dispensing coins until the final rest is received.The module "Program_selector" selects the correct program in case of a successful transaction and provides it to its output to be accessible by the program execution module. When an active signal execute_enable is received, the module "Program_executor" executes the following sequence: dispensing a cup; dispensing coffee; dispensing milk according to the program; dispensing cocoa; dispensing sugar; dispensing water according to the program; open the tap to drain the mixture into the cup; turn on the signal finish.

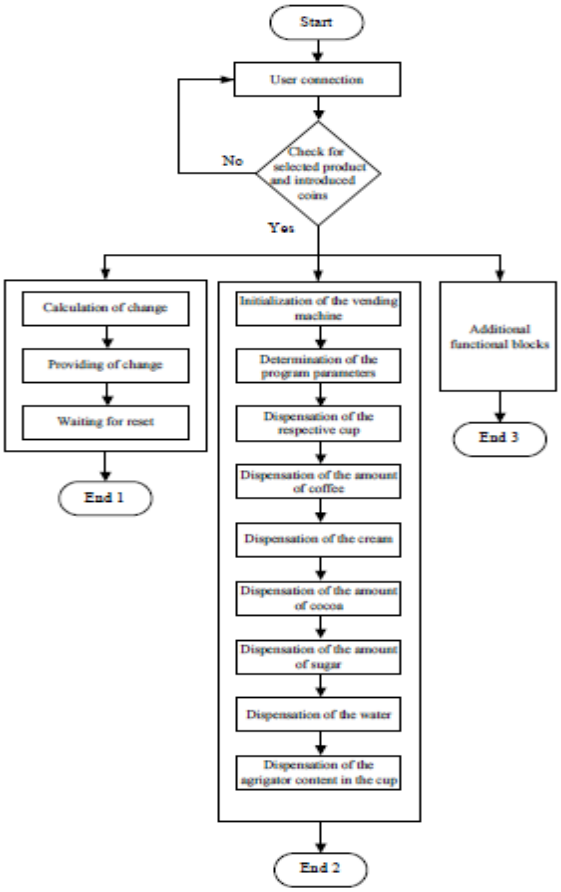

Figure 2: Control algorithm of the proposed system

In figure 2 presents a control algorithm of the proposed vending machines based on the block diagram given in figure 2.

4. RESULTS& DISCUSSION

Simulation results are integral to the success of VLSI design, helping designers ensure functionality, performance, power efficiency, reliability, and manufacturability of integrated circuits before they are physically fabricated.

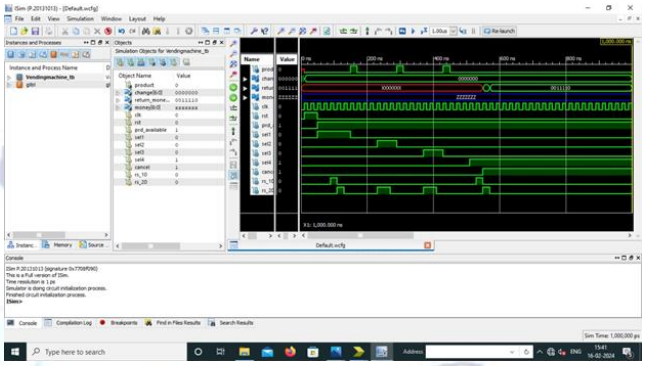

Figure 3: Simulation Result of the proposed system

Figure 3shows the simulation result of vending machine which consisting of the inputs and outputs.

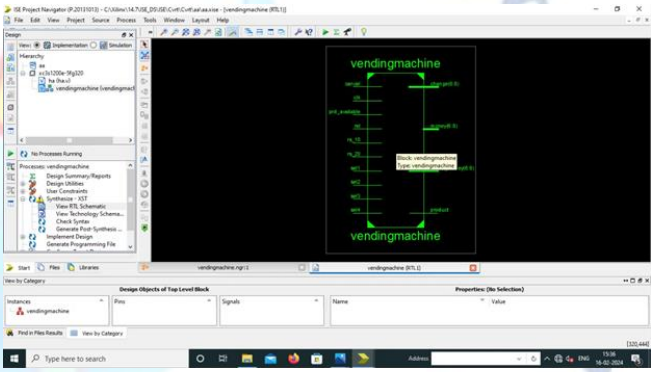

Figure 4: Block diagram of the proposed vending system

Figure 4 shows the block diagram of the proposed system.

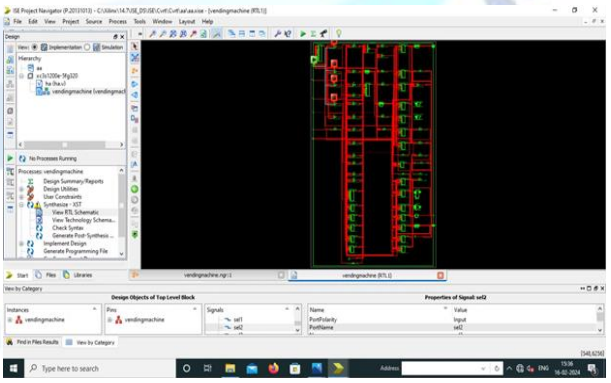

Figure 5: RTL Schematic of the proposed system

Figure 5showsthe RTL schematic diagram of the proposed vending system representing all the sub blocks.

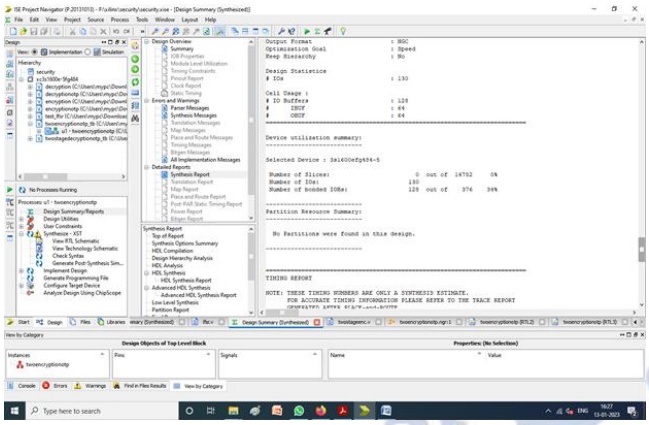

Figure 6: Device utilization of the proposed system

Figure 6shows the area report of proposed system which contain the total number of LUT required for implementation

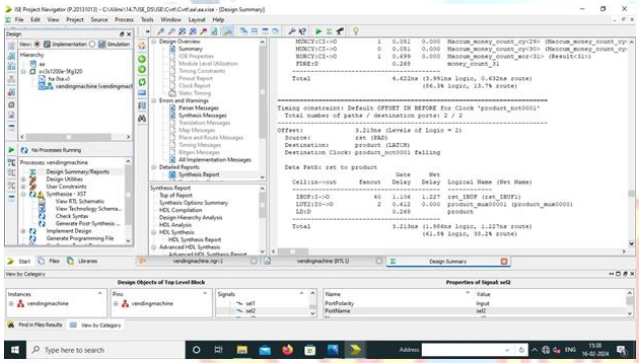

Figure 7: Delay report of the proposed system

Figure 7 shows the delay report of circuit which show the overall delay of circuit.

4.CONCLUSIONS

In the future, the vending machines will be increasingly used due to the many advantages such as low maintenance costs, offering a wide range of beverages, goods, etc. A block diagram for a type of vending machine for coffee and hot drinks has been presented and discussed. On this basis the proposed architecture and the developed control algorithm are described. The control system for the studied vending machine is synthesis and implemented through the hardware description language Verilog HDL. Some simulation results of the different modules are shown and discussed. The results of the research can be applied to other types of vending machines.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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