Research Paper

DESIGN AND IMPLEMENTATION OF VENDING MACHINE USING VERILOG HDL

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ABSTRACT

Vending machines are used to dispense small different products, when a coin is inserted. These machines can be implemented in different ways by using microcontroller and FPGA board. Here in this paper, we proposed an efficient algorithm for implementation of vending machine on FPGA board. Because FPGA based vending machine give fast response and uses less power than the microcontroller based vending machine. The FPGA based vending machine supports four products and three coins. The vending machine accepts coins as inputs in any sequence and delivers products when required amount is deposited and gives back the change if entered amount is greater than the price of product. It also supports cancel feature means a user can withdraw the request any time and entered money will be returned back without any product. The proposed algorithm is implemented in Verilog HDL and simulated using Xilinx ISE simulator tool. The design is implemented on Xilinx Spartan-3A FPGA development board.

KEYWORDS— verilog HDL; kcpsm3; Xilinx ISE simulator; vending machi

INTRODUCTION

A vending machine is a machine that provides items such as four different products even diamonds and platinum jewellery to customers, after the vendee inserts currency or credit into the machine using extremely simple steps. These steps would not be time consuming at all. The vendee would get all the details on the screen which he/she should follow. Previous microcontroller or microprocessor based vending machines were inefficient as compared to FPGA based vending machine. So it is necessary to make it more reliable with efficient algorithm that will be fully commanded by FPGA based solution. The main purpose of this project was to create a vending machine which could provide four different snacks products to the people using extremely simple steps. We have made an attempt to vend four products of different prices in the same machine. The machine will also provide the change to the vendee depending on the amount of money he/she has inserted. It is also possible to withdraw the deposited money in between, if consumer wishes by pressing a cancel button.

1.3 DESIGN OBJECTIVES

To Design a powerful vending machine containing the following features:

1. Sell four different types of snacks and accept three types of coins(Rs1, Rs2, Rs5)
2. Give change after successful trade
3. Return money when trade fails
4. Small size and acceptable power consumption
5. If cancel button is enter, amount will return

KCPSM3 PROCESSOR

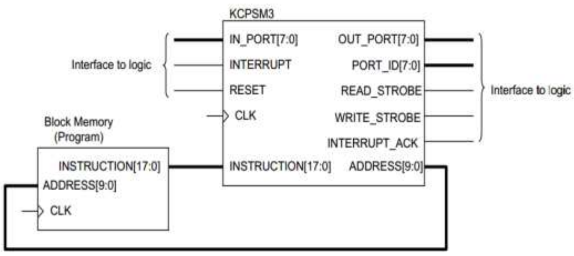


Fig 2.1 KCPSM3

In Fig 2.1, KCPMS3 is a very 8 bit microcontroller primarily for the Spartan-3 devices. It is most likely to be employed in applications requiring in a complex, but not non time critical state machine. Hence it has the name of (K) constant coded programmable state machine.

This revised version of popular KCPSM3 macro has still been developed with one dominant factor being held above all others-size. The result is a microcontroller which occupies just 96 spartan-3 slices which is just 5% of the XC3S200 devices and less than 0.3% of the XC3S5000 device. Together with this small amount of logic, a single block RAM is used to form a ROM store for a program of up to 1024 instructions. Even with such size constraints, the performance is respectable at approximately 43 to 66 MIPS depending on device type and speed grade.

DESIGN METHODOLOGY

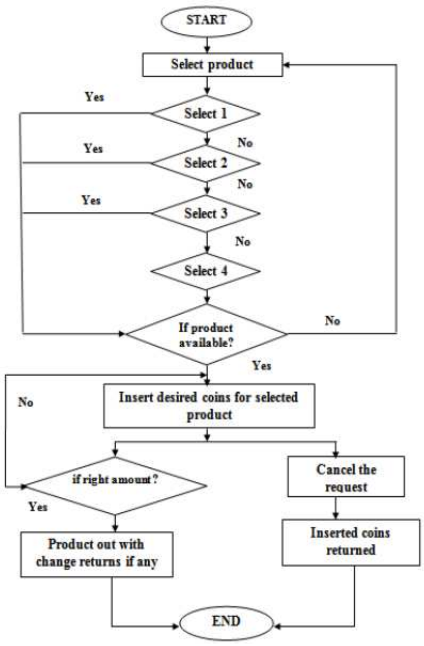


Fig 3 Flow chart of vending machine

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 three types of coins i.e. Re1, Re2, Re5. Let us suppose that the user selects 1 input. The machine will firstly check the whether the products are available in the machine or not. When the desired amount is inserted the machine will go to the product state and 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 Fig 3.

There is also an additional feature of withdrawing the request if the user doesn't want to take the product. When cancel button is pressed then the money inserted will be returned to the user through the return output. A money count signal is used for calculating the total money inserted in the machine. And if the money inserted is more than the money of the product then the extra change will be returned to the user. The total amount of the product taken at a time is shown by the money signal. Similarly the user can select and get the other products following the above procedure.

BLOCK DIAGRAM OF VENDING MACHINE

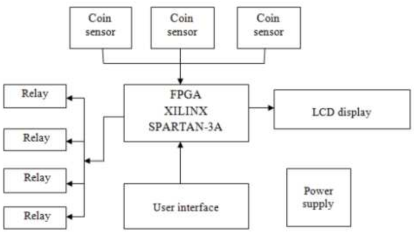


Fig block Diagram

EXPLANATION

In Fig 2, the machine can accept the coins of one rupees, two rupees and five rupees in any possible sequence. There are coin slots and it commonly connected to the FPGA. User interface is used for coin dispense and product dispense. Relay is used to control the product dispatch. The program has written on KCPSM3 processor and downloads into the FPGA Spartan-3A kit by using ELBERT configuration for selecting products, coin sum and balance and it will be display on LCD.

XILINX -3A FPGA

The development board features Xilinx XC3S50A 100 pin FPGA with maximum 68 user IOs. USB2 interface provides fast and easy configuration download to the on board SPI flash. ELBERT features a stable clock source which is derived from on board configuration controller. ELBERT incorporates LEDs and switches for a curious user to get started with his "Hello World" program in a matter of minutes.

COIN DISCREMINATOR

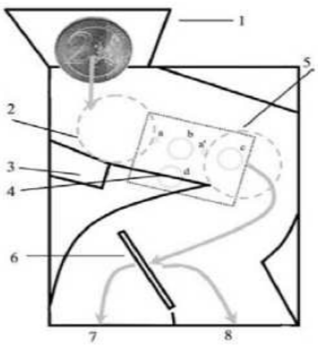


Fig 1.2 Schematic of coin discriminator

1) Coin entry, 2) Coin rolling, 3)Anvil, 4)Coin rolling ramp, 5)IR sensors, 6)Acceptation gate, 7)Coin acceptance chute, 8)Coin rejection chute

When a coin is introduced into the slot, it falls vertically and first hits an anvil, rolling down a short ramp of about ten centimeters. The sensors are located along this path, and their signals have to be processed to decide if the coin is good or a fake before it reaches the end of the ramp, where the coin is driven to the storage or returned to the customer.

The role of the sensors is to measure physical properties of the coins, such as dimensions, conductivity, magnetic permeability, elasticity, etc., and even the existence or not of relief. Only the diameter of the coin, actually its secant, can be directly measured, while for the remaining parameters only indirect information is obtained. This is not a limitation, since what is really needed is to have for each coin a set of parameters, sufficiently large so that, even considering their drifts (due to aging, sensor accuracy, coin trajectory, etc.)

CIRCUIT DIAGRAM OF COIN DISCRIMINATOR

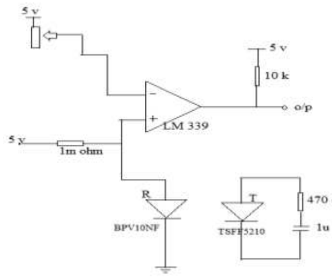


Fig 4.1 Circuit diagram for coin discriminator

RELAY

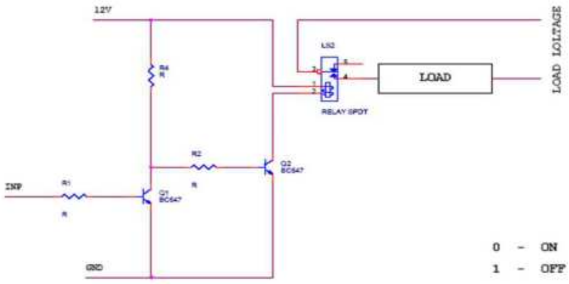
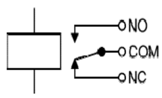


Fig Circuit diagram for relay

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and Normally open (NO).

The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.



The relay's switch connections are usually labeled COM, NC and NO:

- **COM** = Common, always connect to this; it is the moving part of the switch.

- **NC** = Normally Closed, COM is connected to this when the relay coil is **off**.
- **NO** = Normally Open, COM is connected to this when the relay coil is **on**.

CONCLUSION

It was observed through different scenarios, that FPGA based vending machine give fast response and also show low power consumption and easy to use by an ordinary person. Our results clearly indicate that FPGA based solution increases the efficiency and accuracy of vending machines. Also we can monitor the FPGA based vending machine with the main frame computer. Its algorithm is very flexible and reliable as the vendor can easily enhance the algorithm for large number of products and coins of different denominations at low cost as compared to microprocessor based vending machine.

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