SINGLE CHIP SOLUTION FOR VENDING MACHINE CONTROLLER BASED ON FPGA

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Tajuk Projek : **SINGLE CHIP SOLUTION FOR VENDING MACHINE CONTROLLERS BASED ON FPGA**

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Date: 14/6/2012

For my lovely mum and dad, thanks for sacrifice towards my success.

For my supervisor, Pn. Nur Alisa Bt. Ali, thanks for all your supports

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ABSTRACT

"Single Chip solution for Vending Machine Controller based on FPGA" is created to solve the combinational logic circuit and flexibility of vending machine controller that increased the material waste in producing IC and hard to reconfigure when new item or product is added. Combinational logic circuit can be combined into single chip using FPGA and run the operation of FSM. The use of Xilinx Spartan II chip can be launched and strengthen the assembly of this circuit design. With this device, it can reduce the use of combinational logic circuit and reconfigure the programming without too much in hardware changed. The main objective is to develop and design vending machine controller in single chip using FPGA. The output for amount of coins will be display on seven segment LED display.

ABSTRAK

"Single Chip Solution for Vending Machine Controller based on FPGA" diwujudkan untuk menyelesaikan masalah kombinasi litar logik dan fleksibiliti pengawal mesin jual yang semakin meningkat dalam pengeluaran IC dan sukar untuk menyusun atur semula apabila item atau produk baru ditambah. Kombinasi litar logik boleh digabungkan ke dalam cip tunggal menggunakan FPGA dan melaksanakan operasi FSM. Penggunaan Xilinx Spartan II cip boleh dilancarkan dan mengukuhkan pemasangan reka bentuk litar ini. Oleh itu, dengan peranti ini ia boleh mengurangkan penggunaan gabungan litar logik dan menyusun semula pengaturcaraan tanpa terlalu banyak dalam perubahan perkakasan. Objektif utama ialah untuk membangunkan dan merekabentuk mesin pengawal jual dalam cip tunggal yang menggunakan FPGA. Keluaran bagi jumlah syiling yang akan dipaparkan pada 7 segmen paparan LED.

抽象的な

"FPGAに基づいたマシンコントローラを自動販売機用シングルチップソリューションは、"組合せ論理回路やICおよび再構成するのは難しい、新しいアイテムや製品が追加されたときの生産に材料の無駄を増加させ、自動販売機コントローラの柔軟性を解決するために作成されます。組合せ論理回路は、FPGAを使用して単一のチップに結合され、FSMの操作を実行することができます。ザイリンクスのSpartan
IIチップの使用が起動され、この回路設計のアセンブリを強化することができます。このデバイスと、それはあまりにも多くのハードウェアの変更なしで組合せ論理回路を再構成し、プログラミングの使用を減らすことができます。主な目的は、開発し、FPGAを使用して、単一のチップにマシンコントローラを自動設計することです。硬貨の量の出力は7セグメントLEDディスプレイ上に表示されます。

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CHAPTER 1

INTRODUCTION

Electronic devices became a part of our life in the world today. Everyone will use minimum one electronic device in their life. Some of them use for work, entertainment, military and so on. Electronic devices become more helping to everybody and making life easier. Vending machines is the famous electronic devices that can operate 24 hours without being guard by human.

1.1 Background

Vending machines operates as a supplier during injury time to human. Some of this machine supply goods need or desire depends on the manufacturing. Nowadays, vending machine becomes popular due to higher demand from users.

But, in vending machines manufacturing today, they are using a lot of combination logic circuit to generate one output, which is goods. Totally the circuit is fixed and hard to reconfigure back. Even the controller IC (*Integrated Circuit)* only one, it still need and extra IC to operate the system according to the design and programming. Example of Vending machine is show below:

Figure 1.1: Example Vending Machine [25]

Therefore, this project of vending machine controller based on FPGA chip using Verilog programming is created to utilize the state for complex circuit and then to produce an output for users. This vending machine is design using FGPA chip to overcome the complex combinational logic circuit problem and solution for single chip board vending machine controller. FPGA chip stand for Field Programmable Gate Array chip which can be program so many times and it is flexible in term of many input and output that not only depends on external circuit.

The devices that can be program to receive more complex state and can be implementing in single chip will be produced. The devices that based on Xilinx FPGA chip and using Verilog programming will take an input and produce the single output. In the same time, seven segment LED display will be use to display the present value.

Xilinx Spartan II XC2S50 chip with LP2900 board is used to implement the result from the programming that has written in Xilinx ISE. Xilinx ISE is editor for user write a programming and testbench. After that ModelSIM PE is use to produce the timing diagram to show the results. Timing diagram used to compare the results from the simulation and truth table that we have written.

In this vending machine controller, it will accept three coins, but one coins in one time which is 50 cent, 20 cent, and 10 cent. It will produce single output per successful transaction, and balance if have. It consist two products with different price value. After that the system will go back to IDLE state and wait user to insert the coin.

1.2 Problem Statement

Originally, vending machine controller is comprised with a lot of combinational logic circuit to produce an IC. Some drawbacks that arise are in term of the waste in material for using a lot of combination logic circuit. In fact, some of vending machine circuit controller needs an extra memory to store the state, programming and etc. Usually vending machine is designed with fixed control over its nominal money input and its product price and variety, due to user's demand. This control system has tendency to be static and hard to modify neither its nominal money input nor its product price and variety.

1.3 Objective

Objective in this project is to design and develop FPGA based system for vending machine controller operation, implement Finite State Machine method in FPGA chip, to produce single chip for vending machine controller and to generate the single output in form of goods.

1.4 Scope of Project

The system is developed based on FPGA chip by using Verilog programming. Vending machine controller input consists of 3 type of coin which is 50 cent, 20 cent, and 10 cent and produce single output per successful transaction. It has two products with different price value. Verilog programming develops on Xilinx ISE and ModelSIM PE software. FPGA chip that will be use is Xilinx Spartan II XC2S50 chip.

1.5 Methodology

This project begins with the related literature review. Some research had been done on several journal paper, articles, book and internet. These literatures are valuable due to the guidance for better design and development for my projects.

Since this project aims is to develop vending machine controller that is accept input and produce single output by using Finite State Machine (FSM), there will be divided into five phase:

i. Understand the problem
ii. Abstract representation
iii. Truth table
iv. State diagram
v. State minimization

After all this phase is finish, it will follow by the Verilog programming step and testbench to compare the result weather it is same with truth table or not. Here it only involve with the software part. After the simulation test, system integration and erroneous test on the hardware will be done. If an error occurs during simulation, troubleshooting is needed at the Verilog programming and state diagram phase. This is important in order to trace the error at the very first place before proceeding further in this project.

After the simulation test passes, the programming will be implemented on the Leap LP-2900 CPLD/FPGA Experiment Kit using Xilinx Spartan II XC2S50 chip. This board has a built in switch and LED that represent input and output of the system. Seven segment LED display will show the value of coin (switch) that been inserted.

Finally, there will be a prototype construction for the vending machine controller using Xilinx with suitable input, output and display. It aims to increase the audience's understanding on the operation of this system itself and the usefulness of FPGA in electronic devices for future implementation.

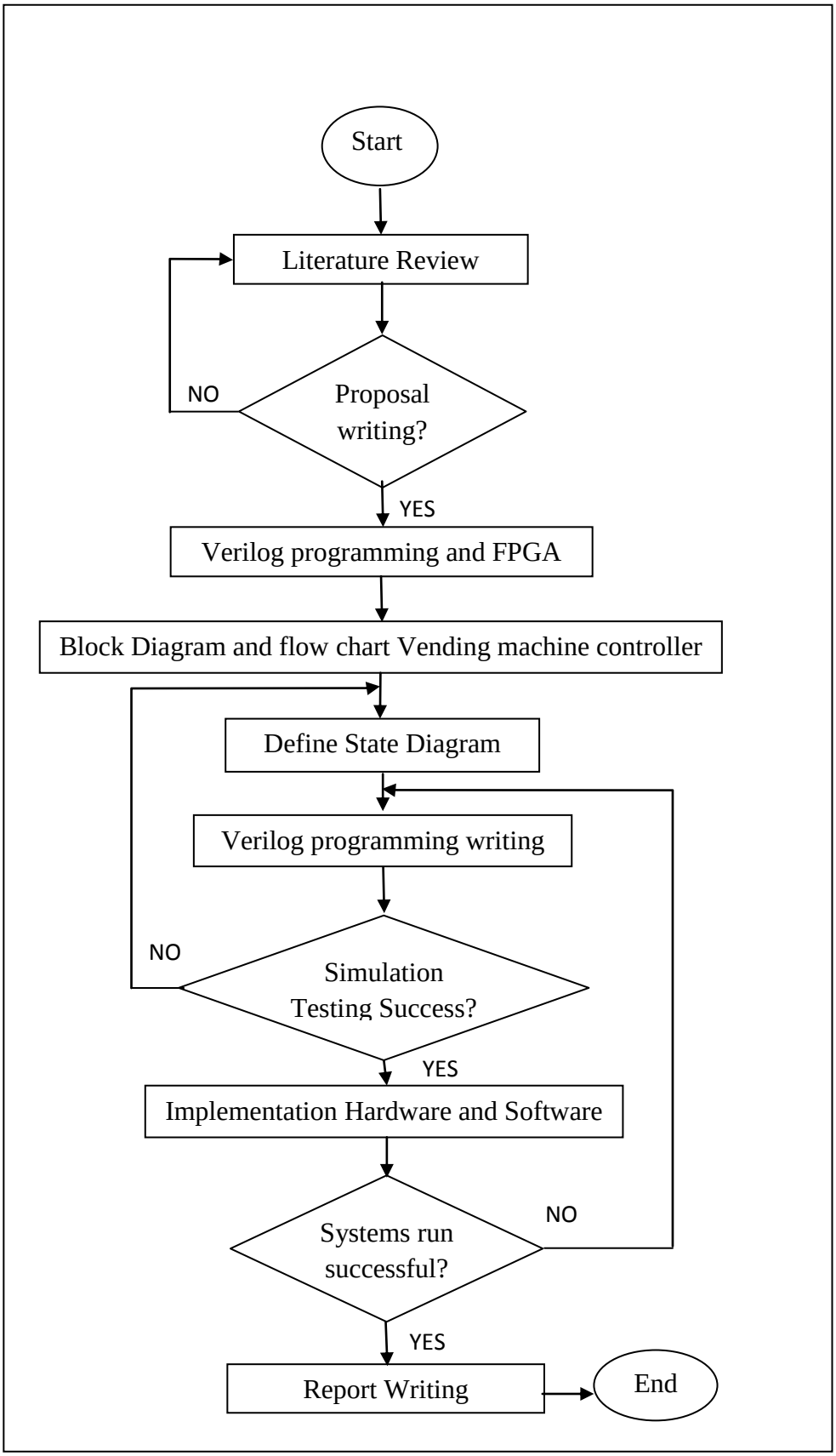

Figure 1.2: Flow Chart Projects

1.6 Chapter Review

This final year project report is consisting of five chapters to describe about Single Chip Solution for Vending Machine Controller Based on FPGA. These five chapters concerned the ideas generated, conception applied, related behavior and finally the development prototype itself which are starting with Introduction, Literature Review, Methodology, Result and Analysis, Discussion, Conclusion and Recommendation.

Chapter I – Introduction that consist of background review of the project, problem statement, objectives, scope of project, briefly explanation of methodology and chapter review.

Chapter II – Literature review about background study that had been done along these projects from the start until the end of these projects. Some of the information shows the different of microcontroller chip and Xilinx chip. In this chapter also mention about journal paper that acts as a guide for better design and develop FSM using Verilog and VHDL.

Chapter III – Methodology describe about the FGPA specification that is used in this projects, programming language which is Verilog, FSM operation, flow chart, state encoding, truth table, and state diagram. In this chapter also explained about hardware that used in this project which is Leap LP-2900 CPLD/FPGA Experiment Kit using Xilinx Spartan II XC2S50 chip.

Chapter IV –Result and Discussion part discussed about system operation which will be implement in future using Verilog programming and problem during the projects.

Chapter V –Conclusion and recommendation part is concludes about the whole project in semester one. It is followed by recommendation for self and university improvement.

CHAPTER 2

LITERATURE REVIEW

Literature review is about background reading that had been done together with this project. Some of the information is used as a reference in this project. The purpose of literature review is to give an imagination, initial view and example or additional knowledge about what need to be done and the main purpose of designing this project.

2.1 History of Vending Machine Controller

The history of vending machine controller is begun in first century where the Greek mathematician Hero of Alexandria invented a vending machine controller to vend holy water in Egyptian temple [8]. His machine will accepted coins and

dispense holy water. Operation of this vending machine started when the coin is inserted, it will fell to pan that was attached to a lever, then the lever will opened a valve and let some water flow out. The lever generally works like a controller to the valve. It will manage the water flow. The pan is more likely became a counterweight for the lever. When coin is inserted, the pan continues to tilt with the weight. Until the coin is fell off, which point a counterweight snapped the lever up and turned off the valve.

The vending machine waited for the Industrial age before coming to prominence [8]. The first vending machine that has been developed is in the early 1880s in London, England where the operation of this vending machine accepted coins and dispensing post cards. In US, the first vending machine in that country was built by the Thomas Adams Gum Company, selling gum on New York City train platforms in 1888. The concept of this vending machine gives Pulver Manufacturing Company an idea where they add small figures, which can attract somebody, would move around to buy the gum from their machine.

The brilliant idea generates a new type of vending machine that was using mechanical device known as the “trade simulator”. In the same year of production, slot machine and pinball had been produced.

Completed coin-operated restaurant was opened in 1902 and stayed opened until 1962. In this restaurant have vending machine that offered everything including; cigars, postcards, stamp, etc [9].

In Texas, Ussery Industries of Dallas produced “talking” vending machine where the machine will said “thank you” and an added one –liner voiced by comic Henny Youngman. This vending machine is called the Venda Talker. It was produced in December 1970.