Journal of Advanced Computing Research Vol. 3, Issue 1 (2018) 1-4

Bit-level Parallelism - A Case Study on 16-bit Microprocessor

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***Abstract*—Bit level parallelism is how computer uses parallel form to increase the processing work size. There are many designs that can be used to implement the 16-bit microprocessor in real life application. The design will be used in single machine cycle that can increase speed of the process. Microprocessor is a register based electronic device that can be programmed and it accepts binary data as input, progresses on the data that are based on the binary instructions and provides the result as output. It can integrate enormous processing power even in a compressed space. Microcontrollers are significant in this digital world where everyone wants to finish the intended task in a minimum time.**

***Keywords:* bit-level, parallelism, 16-bit microprocessor**

I. Introduction

Microprocessor is the electric component inside the computer that handles and runs the computer. It is central processing unit that consists of integrated circuit such as resistor and transistor. Users will give lots of precise instructions to the computer and microprocessor will handle the situation in a flash which will make users work more easily. Microprocessor are conducted in symbols and numbers that are represented in binary. The binary data will be acted as the instructions are stored in the memory located in the microprocessor and will process the output as result.

A. Definition

Bit-level parallelism is where the computer works in parallel form to execute the word size processes. By increasing the data in words size, it can reduce the number of instructions needed to complete the process. The size of the word must be greater than the length of the word. A 16-bit microprocessor can complete the process with only one single instruction.

Microprocessor acts as the fastest component CPU in a computer to execute the process. By collecting several data, executing the process will make it easier than redesigning it. It is multipurpose clock driven component. The whole processes in microprocessor require one pulse per second for it to complete. It works on numbers and images spoken to in the parallel numeral framework.

II. Background

In computer architecture, 16-bit integers are commonly found in memory address and other data. It makes up to form ALU and CPU that are found in the microprocessor. A 16 bit-register can store 2^{16} data.

The first 16 bit-microprocessor introduced was in 1973 which is National Semiconductor IMP-16. Then more models were introduced which included Intel 8086, TMS 9900 and National Semiconductor Pace. The last known 16-bit microprocessor were Intel 80287 and Intel 80187.

III. Paper Review

Several papers have been reviewed in order to fully understand the use of 16 bit-microprocessor in the computer.

A. Control Unit Design of a 16-bit Processor using VHDL

16-bit microprocessors are designed and implemented to the real life application. It can be executed by using the Very High Description Language (VHDL). The CPU (Central Processing Unit) execute the projects that were away in the primary memory by getting their guidelines, looking at them, and executing them in a steady progression. The CPU consists of a few parts, like memory units, control path and data path.

Control Unit is essential for operating the data path to generate the control signals that are automatically completed at each clock cycle. Figure 1 below shows the simulation results for control unit [1].

Figure 1. Simulation results for control unit [1]

B. Designing of 16-bit Microprocessor's Functional Units - CPU, ALU and RAM

VHDL is used to visualize the data flow and control signalling inside the 16-bit microprocessor. The processes conducted are deeply discussed in this paper.

The functions of all the key components of microprocessor such as ALU, RAM and CPU are imagined logically through the VHDL waveforms. Writing code for VHDL can provide more details on functions that are contained in the microprocessor [2].

C. Design and Analysis of 16-Bit Micro Processor using Xilinx Tool [3]

The Xilinx tools are used to implement the design of a 16-bit microprocessor into the real life application. The processor executes the vast majority of the directions in a solitary machine cycle which produce faster [3].

The processor has been designed using VHDL and it can be implemented on an FPGA. The major components of microprocessor like ALU, comparator, shift register, control unit and registers are designed and implemented.

D. Design and Performances Analysis of 16-bit RISC Processor using Xilinx Tool [4]

The design of a 16-bit non-pipelined RISC processor for applications in real-time embedded systems is described.

By using VHDL to implement the microprocessor design, it can reconfigure it as indicated by particular prerequisites of the objective applications. The main purpose of this paper is to design and implement a 16-bit Reduced Instruction Set Computer (RISC) processor using Xilinx Spartan 3E tool. It includes composing a VHDL model, creating test-seat and mimicking the conduct [4].

The important parts of processor consist of the Arithmetic Logic Unit (ALU), shift register, Rotator and Control unit. The guideline code is obtained towards the start of each cycle, all operations are executed amid the clock time frame, and results are put away towards the finish of it.

E. Design and Implementation of a 16-bit Microprocessor based Power Recorder [5]

The R and D work of making a 16-bit microprocessor based power recorder which can keep the record of the line voltage for twenty-four hours at an interval of one minute is presented [5].

Sensor is used in the design with half wave rectifier. A 16-bit Microprocessor Learning/Development System using Intel 8086 architecture have been used for interfacing the circuit. It can sense the line voltage from 0 to 250V.

F. 16-bit Embedded Microprocessor for Information System using FPGA

An information processing system also uses resistor level of 16-bit information processor for wireless communication hardware. The information processor will execute diverse types of commands such as sub, add, load, and jump. For these commands to be executed, it has to exchange sub, add, load, jump into binary bits. For the diverse type of commands, the binary bits will help to distinguish the overall processes. Executing any of the commands is the main work in order to create control signal. Different form of control signals is made for different commands.

In the beginning of the process, when it turns on the processor, there is no input available in the RAM so some command sets have to be written in binary bit that would be implemented. The instruction will be executed one by one when the number is 1, the instructions would be written and set to 1. FPGA are used to show the response of time of executing the commands. Timing reaction of all blocks have been analysed and final TOP blocks FPGA.

G. Analysis of 16-bit Microprocessor: Architecture on FPGA using VHDL

VHDL are used to design, stimulate and implement 16-bit microprocessor architecture on FPGA. Important structures such as the speed that increase minimum execution real-estate, reduction in power and highest configurability are offered by several FPGAs. By using only single FPGA, design can be achieved where it needs 6 to 10 ASICs.

In order to programme FPGA, VHDL is used. VHDL is an abbreviation for Very High-speed integrated circuit hardware Description Language. It actually represents the written description of a hardware project or a part of the design which, when simulated, it mimics the design performance.

The processor contains numerous basic modules. These modules are an ALU, register array of 8x16 bit register, program counter, shift register, an instruction register, a comparator, an address register, and control unit. All of these modules are gathered together and correspond through a common 16-bit data bus.

H. A 16-bit Fully Functional Single Cycle Processor

The current business microprocessors are provided as black box components, which users are incapable to monitor internal motions and procedure method, neither can they adapt the original arrangement. This problem can be solved by 16-bit fully well-designed single cycle processor that is designed for its architecture and its well-designed capabilities.

The key structural design elements, the hardware block figure and interior structure are being described. VHDL are modified by the processor and accesses are given to all internal signal. The design of ALU are optimised for the processor to consume less resource. The RTL views and verified simulation results of processor are shown in Figure 2. Xilinx ISE 9.2i tool are used to write the VHDL code for design architecture for the synthesis and simulation process.

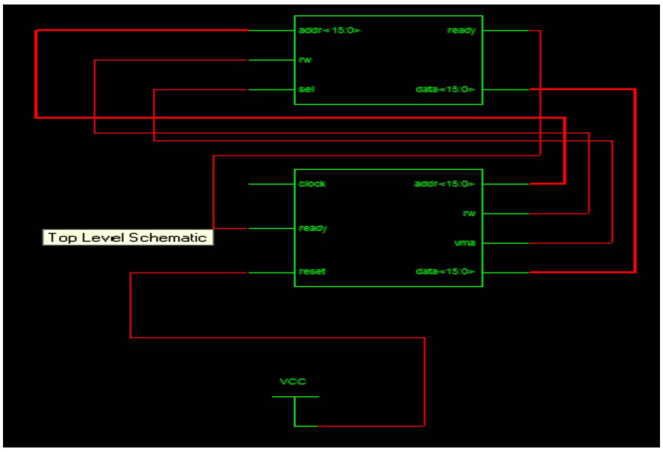

Figure 2. RTL Schematic of 16-bit Microprocessor

I. Design, Implementation and Testing of 16-bit RISC Processor

Embedded processor is the most significant fragment of an embedded system. The execution of embedded system is determined by the execution of embedded processor. An embedded processor is known as a Reduced Instruction Set Computer (RISC). This paper presents the procedure for design, implementation and testing of a 16-bit RISC processor. The Field Programmable Gate Array (FPGA) has been experimented on the processor and are tested on the FPGA development board. To demonstrate the available hazards in the pipeline and the technique used to find the solution, it is very useful to use the processor.

J. Designing of a 16-bit Microprocessor's Functional units-CPU, ALU and RAM (not valid)

VHDL are used in recreation of a 16-bit microprocessor's hardware to envision the control signalling and data flow inside the microprocessor. Functions of every key element such as ALU, CPU and RAM are analytically visualized through the waveforms of simulated VHDL (Figure 3). All the components simulated are tested by separately writing the VHDL code for them.

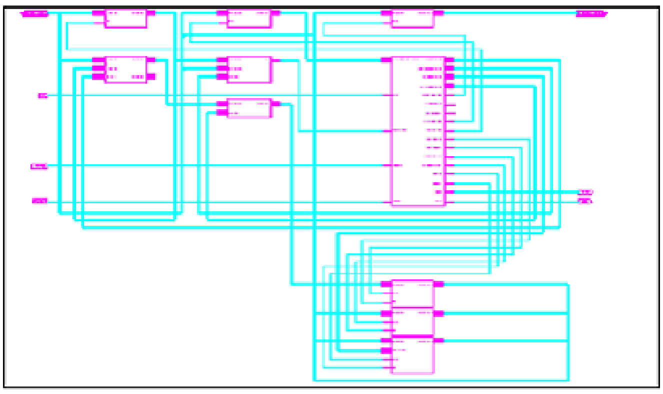

Figure 3. Internal Structure of the CPU

K. Design of a 16-bit RISC Processor

Custom design approaches are used to present the design of a 16-bit Reduced Instruction Set Computing (RISC) processor. The form of processor engaged in a system claims its effectiveness. The areas are reduced by the compressed order integrated in the design and powers of the processor are dissipated. The combination of the numerous efficient blocks is done based on the states that arrive for the implementation of each command. The power for the execution of the AND instruction can be found by RISC processor to be consumed with a delay of 1600ns. The processor consumes about 77.6mW of power that are dissipated for the execution of the ADD command with a delay of 1900ns.

L. Design and Implementation of 16-bit Processor on FPGA

This paper presents the designing and implementation of 16-bit processor using VHDL, a very high speed integrated circuit hardware description language, on FPGA Spartan-6 kit. The CPU, shifter, comparator, control unit and memory are integrated in proposed processor. The processor has 16-bit arithmetic and logical instruction set analogous to 8085 and also includes multiplication and division instruction. The control unit generates all the control signals needed to control the coordination among the entire components of the processor. All the modules in the design are coded in VHDL to ease the description, verification, simulation and hardware implementation. The design entry, synthesis, and simulation of processor are done by using Xilinx ISE 13.2 software and implemented on XC6SLX16-2CGS324 Spartan-6 FPGA device.

M. VHDL Design and FPGA Implementation of 16-bit Microprocessor

Microprocessors are possible to be implemented by the use of VLSI design and it is also able to program the design onto a single combined circuit by using VHDL. A 16-bit microprocessor is designed with 16 instructions. The FPGA that is used to implement the circuit is the Xilinx Spartan3E FPGA device. The Xilinx ISE Design is the working tool that suits the 13.2 Modelling Simulator. The simulator is used for the simulation, functional, and implementation of the VHDL model.

N. A Low Power 16-bit RISC Microprocessor using ECRL Circuits

A low power 16-bit Reduced Instruction Set Computer (RISC) microprocessor are presented in this paper with the Effective Charge Recovery Logic (ECRL) registers. The processor consists of a control block, registers, a program counter, arithmetic and logical unit (ALU), and a register file. The whole circuits are designed based on ECRL by using a CMOS technology. An adiabatic latch that is found on the ECRL is recommended for signal interfaces for the very first time, and power for the adiabatic processor are provided by an effective four-phase source clock generator. A static CMOS processor that has the similar architecture is structured to relate the adiabatic and non-adiabatic microprocessors energy consumption. Simulation products show that the adiabatic microprocessor power consumption is about a third compared to the static CMOS microprocessor.

IV. Conclusion

Bit-level parallelism is generally easy to configure contrasted with coarser grained parallelism but it was not broadly utilized in light of issues of abusing the systems utilizing existing innovation and instruments. VHDL and Xilinx tools are endeavors at rearranging the utilization of the bit-level outline however the full misuse can just come through consolidating insight. However, they are only an intermediate solution compared to the full gate and bit-level design implementations.

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