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Teaching Computer Architecture Using Simulation Tools

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***Abstract*-The purpose of this paper is to emphasize the importance of having simulation tools in teaching computer architecture and organization course and to introduce few simple simulation tools that could be used for this purpose. This simulation tools helps the students to be familiarized practically with the computer through developing their own circuits, instruction sets and programs.**

***Keywords*-**Simulation, Computer architecture, logisim, cedar, cpusim.

I. INTRODUCTION

Computer Organization and Architecture is one of the important subject offered at universities across the world [1]. Teaching in traditional way can be insufficient if the teaching focus is solely on the textbook materials [1,2,3]. One of the most critical aspects on teaching this discipline is how to support the theoretical concepts of the subjects with appropriate practical experience, usually organized as laboratory experiments [4]. But practically, even with these experiments students are unable to understand the subject. For this reason, many educators have begun using different computer architecture simulators based on hardware and software to solve this problem [5]. In this paper we brief mainly about three simulators: Logisim, CEDAR and CPU Sim.

II. LOGISIM

Logisim is a simple software which can be used for implementing circuits with basic gates. Users of this simulator can draw the circuits using the tool box available [6]. The circuit automatically propagates circuit values through the circuit by selecting the suitable tool and the user can toggle the input conditions to learn how the circuit behaves in other situations. Students themselves were able to understand how to connect basic gates to make simple as well as complex circuits with the help of Logisim. We used the simulator Logisim for sharing GATE level knowledge to the students and with the help of this they were able to do different units such as Logical unit, Arithmetic unit and Shift unit of a simple computer.

Students can create the complete circuit with Logisim and can run the simulation with any possible input and this gave an experience as they were in the lab. Students find Logisim simple to follow, and find the laboratories designed around it useful in reinforcing the circuit concepts received from class.

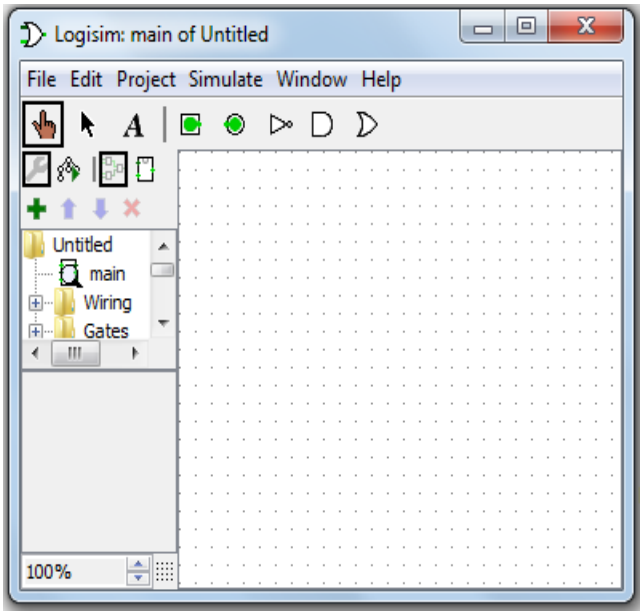

Figure 1. Logisim simulator window.

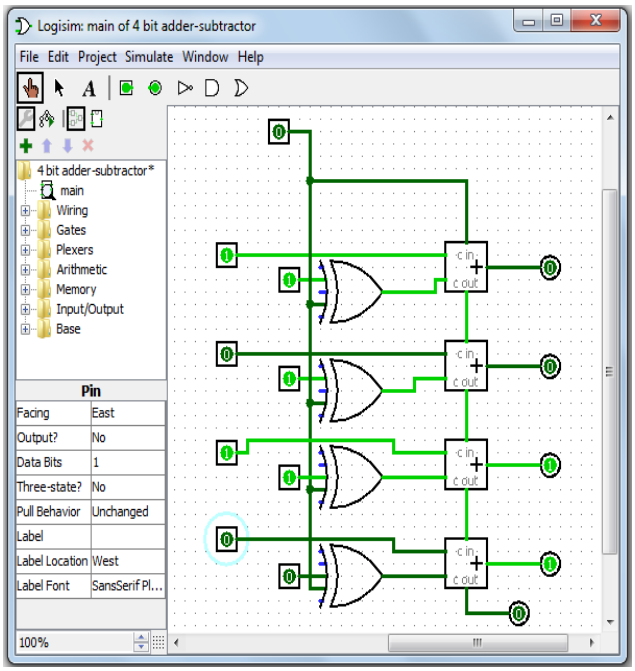

Figure 2. Implementation of a 4 bit adder-subtractor circuit using Logisim.

III. CEDAR

CEDAR is a powerful simulator in which the students can implement a complete computer and will be able to understand the internal details of a computer more clearly. Using CEDAR Simulator students can 1) build the entire computer hardware using fundamental logic gates; 2) write an assembler to translate the test program into machine level program ; 3) load the program into the memory of the computer; and 4) run the test program on these hardware[7]. After the implementation students can see how a computer executes a program and what are the signals generated during each clock pulse.

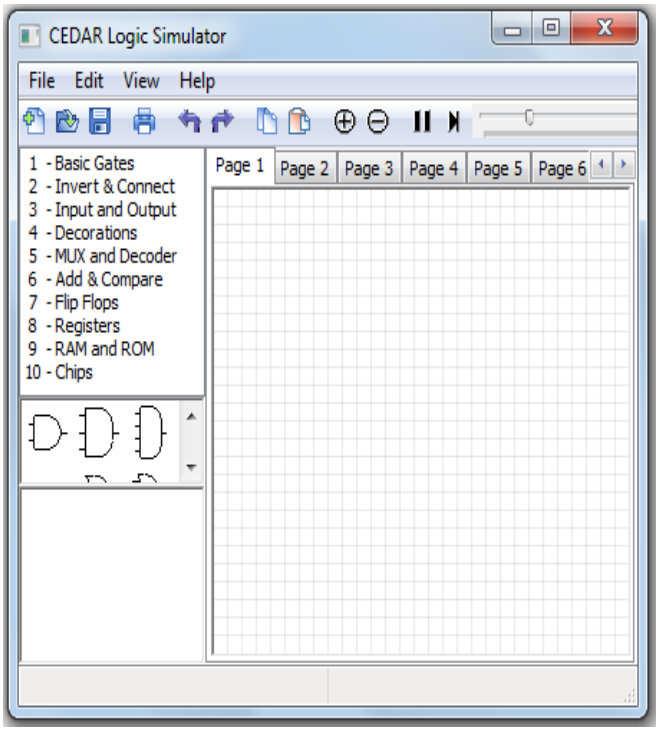

Figure 3. CEDAR Simulator Window

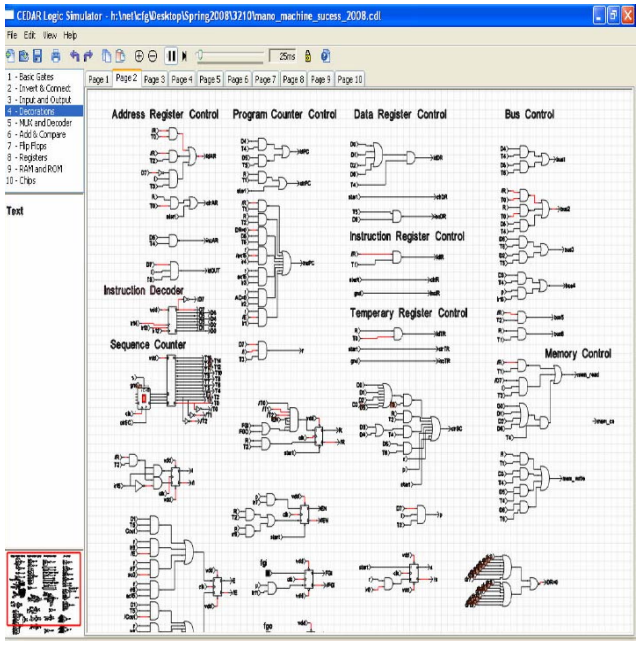

Figure 4. CEDAR simulation for a control unit.

IV. CPU SIM

CPU Sim is an interactive simulation tool in which the user can specify the details of the CPU to be simulated, such as register set, memory, set of microinstructions, set of machine instructions and set of assembly language instructions [8]. Users of the tool can write their own machine or assembly language program and run on the CPU they have created. It simulates the computer architecture at register transfer level so that the students will get a better understanding about the system. User of the simulator has to specify the hardware units and the microinstructions for the CPU and then create the set of machine instructions. Corresponding to each machine instruction a sequence of microinstructions is to be formed.

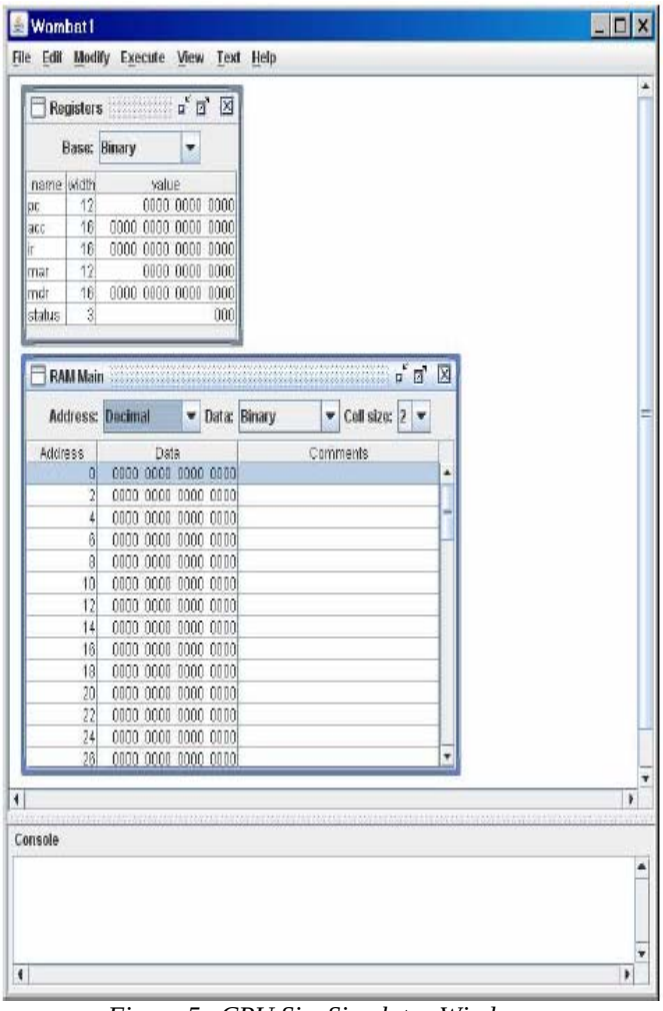

Figure 5. CPU Sim Simulator Window.

Once the instruction set has been specified, students can write programs for their new CPU, either in machine language or in assembly language. Simulator executes the given program through repeated execution of machine cycles. Each machine cycle has two parts: Fetch sequence and Execute sequence. In fetch sequence the next instruction to be executed is loaded into the instruction register and then decodes it. In the execution sequence, CPU executes the decoded instruction with the help of microinstruction which is already been defined.

V. CONCLUSION

This paper addressed the importance of simulation tools in learning computer architecture and organization. These tools can be used as practical components addition to the computer science and engineering curricula. It has been observed from the survey among students, this new method of teaching helped them for getting better understanding of computer and can model their own microprocessor and microcomputer.

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