

# Implementation of the Virtual Laboratory for 8051 Microcontroller

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*Abstract:* - A virtual laboratory uses computer-based simulation to emulate hardware. In this paper, we proposed a virtual laboratory on microcontroller 8051. The microcontroller virtual laboratory is a Web-based laboratory for students' operation at any place and in any time. It is accomplished using Java applet and Flash animation for complete comprehension of microcontroller 8051. The proposed virtual laboratory was implemented by Java Applet and Flash animation, which allow high flexibility in time scheduling because they do not require time limitation and isolated practical laboratory space. Once students have an experience in the proposed virtual laboratory, they are expected to perform experiments in their own way without additional time loss and fear of damaging the 8051 microcontroller training kit.

*Key-Words:* - 8051 microcontroller, virtual laboratory, Java Applet, FLASH animation

## 1 Introduction

The Internet has become a widespread tool for teaching and learning. The use of virtual laboratory techniques emerges as a new possibility in training students. It is clear that training students in a virtual laboratory has certain advantages. First, it makes possible for students to practice the operation of complicated instruments such as oscilloscope, embedded system, VHDL, network analyzer, and others. Second, it offers the possibility for 'hands-on' training in diverse tasks in the lab such as sample logistics and administration, data processing, method development, and above all, instrument maintenance and service. Today's virtual laboratories are using simulation of instrument operation as a primary tool for software development. The theory, the instrumentation and the exercises of the experimental procedure are the contents of some popular books. A virtual laboratory is mainly for training in instrumentation, method development and data processing of instrumental methods of analysis, completing and

even replacing traditional laboratory training. However, it appears that virtual laboratories significantly contribute to better understanding of the fundamental principles and theories of each experiment. The use of Flash animation and Java applets in a virtual laboratory result in better understanding of the experimental theory and procedure. They provide students with opportunities to run equipment without cost, risk and time limitation. It builds experience in each method, allows flexibility in time schedules, and does not require much time and isolated laboratory space. In this paper, we proposed an virtual laboratory for 8051 microcontroller, which operates dynamically using JAVA applet and flash in order to confirm and understand execution results easily.

## 2 A Design of Virtual Laboratory and Implementation

### 2.1 Introduction of 8051 Microcontroller

A microcontroller is an integrated chip that is often a part of an embedded system. A microcontroller includes CPU, RAM, ROM, I/O ports, and timers like a standard computer, but because it is designed to execute only a single specific task to control a single system, it is much smaller and simplified so that it can include all the functions required on a single chip. A microcontroller differs from a microprocessor, which is a general-purpose chip that is used to create a multi-function computer or device and works together with other chips to handle various tasks. A microcontroller is meant to be more self-contained and independent, and to function as a tiny, dedicated computer. 8051 is one of the most popular 8 bit microcontrollers and combines an instruction set that allows tight coding of small I/O-intensive applications with enough power and a sufficiently large program space that can be used with C. Despite its relative old age, 8051 is still the most commonly used microcontroller at present. Thus, we chose a 8051 microcontroller and developed a virtual laboratory. The virtual laboratory contains experimental contents related with each program using Java and Flash. Learners can learn in a quick and easy way how to program a 8051 microcontroller in the virtual laboratory.

**2.2 8051 Microcontroller Virtual laboratory**

Lecture notes shown in Figure 1 include general contents for the 8051 microcontroller such as architecture, instructions, addressing mode and interrupt. To enhance the learners’ comprehension, Flash animation or Java applets are provided. The entry point of the virtual lab is principle lecture notes written in HTML, Flash and Java applet program. Learners are guided to follow the learning sequence shown in Figure 2.

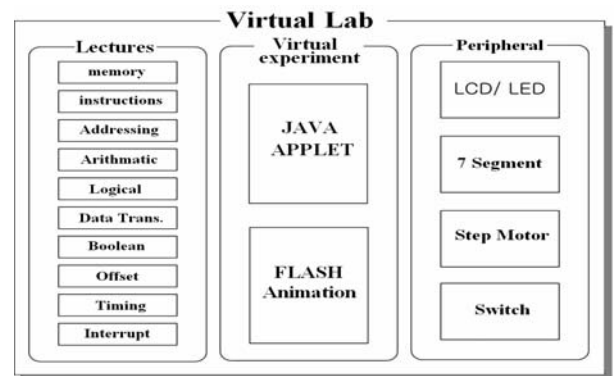


Fig. 1 Studying process of virtual laboratory

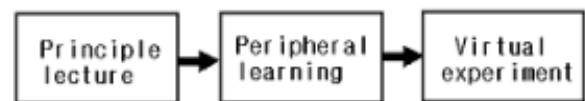


Fig. 2. Learning sequence of virtual experiment

The example in Figure 3 shows the operation process of MOV among 8051 instruction set. The format is MOV operand1, operand2. MOV copies the value of operand2 into operand1. The value of operand2 is not affected. Both operand1 and operand2 must be in the internal RAM. No flags are affected unless the instruction is moving the value of a bit into the carry bit in which case the carry bit is affected unless the instruction is moving a value into the PSW register (which contains all the program flags). The learner can easily understand the MOV instruction through animation.

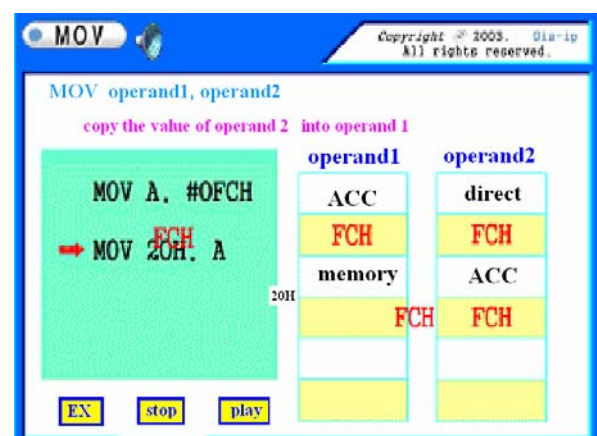


Fig. 1 Animation of MOV instruction

■ The virtual Lab using FLASH Animation

To teach how to program the 8051 microcontroller, sample programs are provided. The left lower part in Figure 4 shows an assembly program for printing characters on the LCD. Learners can trace the program step by step by just clicking the line and then observe the execution results through the simulated memory region and stack region shown in the right part of Figure 4, and the simulated LCD in the left upper part of Figure 4. Figure 5 shows a comprehensive Flash animation for controlling LED.



Fig. 4 Animation for outputting characters to LCD

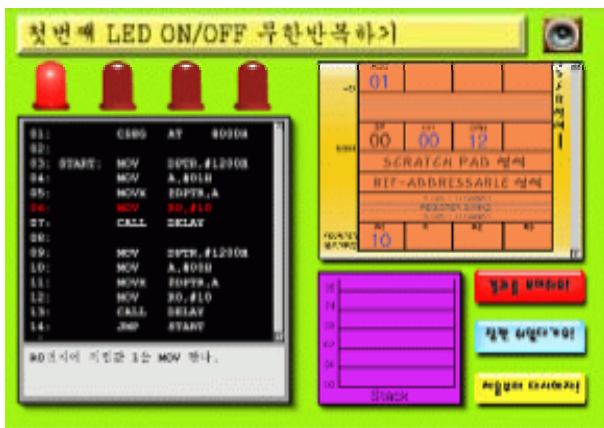


Fig. 5 Animation for lighting LED

source program is displayed in white color using a thread in the source program. Figure 6 shows examples of virtual laboratory for a step motor with 7 segments. Learners can confirm processes executed by a program to control the angle and direction of stepper motor rotation in Fig 6(a). We assumed that the 7 segments are connected to port 1 of the 8051 microcontroller. To display a number in the 7 segments in Fig 6(b), learners write a program using MOV instruction sending a 7-segment equivalent ASCII code to port 1.



(a) stepper motor



(b) 7-segment

Fig. 6 Java Applet for peripheral devices

### ■ A virtual Lab using Java Applet

We developed an interactive system that shows various results according to input value using a JAVA applet [7-8]. After learners choose a specific value in the loop control value drop box in the middle of the source program, they can guess and confirm the result of the choice. The executing line is displayed in red color and the remainder of the

### 3 Conclusion

This paper proposed a virtual laboratory in which students can always experiment the 8051 microcontroller virtually and repeatedly several times. The virtual laboratory for the 8051 microcontroller was embodied using JAVA applets and FLASH animation. Various animations of concepts as memory action processes that are hard

to understand were produced using Flash, and JAVA applets of algorithm comprehension were manufactured to confirm the effects of input made by users. There are advantages that the virtual laboratory can improve students' comprehension of studying in real experiments, and experiments can be made repeatedly and in a short time. Furthermore, in case a hybrid microcontroller laboratory which is integrated with a remote laboratory for 8051 circuits in the server side will be constructed, the system may make up for the weaknesses of a general virtual laboratory. Virtual laboratories contains more diverse contents will be added hereafter.

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