



## **Chapter IX**

# **A Virtual Laboratory for Digital Signal Processing**

Chyi-Ren Dow, Feng Chia University, Taiwan

Yi-Hsung Li, Feng Chia University, Taiwan

Jin-Yu Bai, Feng Chia University, Taiwan

## **Abstract**

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*This work designs and implements a virtual digital signal processing laboratory, VDSPL. VDSPL consists of four parts: mobile agent execution environments, mobile agents, DSP development software, and DSP experimental platforms. The network capability of VDSPL is created by using mobile agent and wrapper techniques without modifying the source code of the original programs. VDSPL provides human-human and human-computer interaction for students and teachers, and it can also lighten the loading of teachers, increase the learning result of students, and improve the usage of network bandwidth. A prototype of VDSPL has been implemented by using the IBM Aglet system and Java Native Interface for DSP experimental platforms. Also, experimental results demonstrate that our system has received many positive feedbacks from both students and teachers.*

## Introduction

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Digital signal processing (DSP) (Mousavinezhad & Abdel-Qader, 2001; Texas Instruments, 2005) is one of the most powerful technologies in the twenty-first century and is a growing subject area in electrical, computer science, and other engineering/science disciplines. DSP is closely linked to our life and is widely applied in many fields such as: telecommunications, robotics, consumer electronics, medicine, military, instrumentation, aerospace industry, and automobile. Each of these areas has developed a deep DSP technology, with its own algorithms, mathematics, and specialized techniques.

Although DSP is the trend of current technology development, the learning of DSP is not an easy task for novices. Not only the DSP hardware architecture, but also the flexible and powerful instruction sets of DSP chips are difficult for students. Thus, fast and convenient CAI tools for the DSP learning are necessary. However, most DSP learning tools are stand-alone. This kind of learning approach has only human-computer interaction and lacks of human-human interaction (Dey, 2000; Dow, Lin, Shen, Lin, & Chen, 2002) such as teacher to student and student to student. In order to add human-human interactions, it is necessary to create network capability for DSP-learning tools. A network enabled DSP learning environment can support multiple users and allow them to interact with each other to increase their interests in learning DSP in any place and at any time via the Internet.

In addition to the network capability, a DSP virtual laboratory should support the features of multimedia and multi-level usage. The multi-level usage means that the same learning materials can be organized in different ways to be used in a regular semester course, a short course, an introductory exposition, an advanced seminar and so on, and by people with different linguistic, cultural, and perceptual preferences (Arndt, Chang, Guercio, & Maresca, 2002). Through multimedia demonstrations, students can easily understand various DSP theories. We can use the multimedia technology to enhance an experimental environment for students. Furthermore, a DSP course material should be organized in multiple levels so students can select DSP studying materials according to their ability to reduce the frustrations when learning and deepen their impressions about DSP.

This work designs, develops, and implements a virtual DSP laboratory, VDSPL using mobile agent and wrapper techniques. The autonomous feature of mobile agents can be used in the virtual laboratory to substitute for a teacher's behaviors and actions in a practical laboratory. Mobile agents could guide several groups of students in different places simultaneously. When a student needs to interact with the teacher, the virtual laboratory can dispatch a mobile agent to perform this function. For a student, the mobile agent can play a learning guide and

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