

# Virtual Programming Lab for Online Distance Learning

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**Abstract.** In this paper, we describe the design of the WebVPL system, a Web-based Virtual Programming Lab for on-line distance learning. The underlying setting is a collection of Lab server computers hosting education and programming software. Students use personal computers at home to access over the Internet one of the Lab servers, which performs functions to accommodate various requests from the student such as software usage. The lab servers can be located in different buildings and even at different campuses. WebVPL facilitates resource sharing among different schools and overcomes the limit of geographical distances. The design of the WebVPL system includes the user interface, agent-based client side functions, the structuring of Lab servers, the mechanisms to locate user requested software packages / services and to present various forms of data and information, and the interfaces to various education and programming software packages. We discuss various implementation issues and describe a prototype of the WebVPL.

## 1 Introduction

During the last several years, e-learning has emerged as one of the fastest-moving trends in education and is booming. Thanks to the widespread access to the Internet, on-line education is enabling students and professionals to learn from afar, keeping pace with technological and managerial changes. Thousands of technical and management courses are now being offered by universities, for-profit professional development centers, and industry training facilities worldwide [24].

Underpinning the teaching and learning over the Web, the global connectivity of the Internet and a new generation of hardware and software applications have equipped distance learning with new methods of delivery. The convenience of Web education made distance learning effective and flexible, even in the absence of face-to-face interactions in the classroom. Nowadays, students who take courses on-line can access the courses whenever and wherever convenient. They can download the

lecture note from the Web, communicate with each other and their instructor through e-mail, and took exams by responding to questions on computer screens.

Although several e-learning software supporting on-line lecturing and tutoring have been found popular [13,22,23] and many works have been done in providing Web-based learning and teaching [8,19,20,24], there has been not many reports on providing students convenient on-line access to programming facilities available in computer labs. Only a few works can be found which develop either ad hoc or special purpose Web programming facilities [14,17,18]. In this paper, we describe the design of the WebVPL system, a generic Web-based Virtual Programming Lab for on-line distance learning. The powerful features of the WWW, especially the integration of the widespread Internet protocols, allow us to design software to facilitate the access to existing resources available on the Internet in an integrated fashion [9]. In addition to navigation through hypermedia documents, using the remote access capability of the Internet technology, various software programs can be executed remotely through WWW. In WebVPL, the underlying setting is a collection of Lab server computers hosting education and programming software. Students use personal computers at home to access over the Internet one of the Lab servers, which performs functions to accommodate various requests from the student, ranging from downloading software from the school lab servers, working through interactive demonstration and tutorial sessions, and submitting a program for execution on a Lab computer using specified software package.

The collection of Lab server computers forms a *virtual* programming laboratory because the machines can be located in different buildings and even at different campuses. It facilitates resource sharing among different schools and overcomes the limit of geographical distances. The WebVPL system design includes the user interface, agent-based client side functions, the structuring of Lab servers, the mechanisms to locate user requested software packages / services and to present various forms of data and information, and the interfaces to various education and programming software packages. Technologies such as virtual reality, Java Applets and Servlets, mobile agent, XML, and Web/HTTP servers can be used to implement the underlying mechanisms and facilities of the virtual Lab, such as software resource locating and interfacing, real-time interaction, and information presentation. Using these technologies allows the system to achieve high-performance, scalability, and disconnected operation through reduction in network bandwidth and delay, load balancing, and code mobility.

The rest of this paper is organized as follows. Section 2 describes the requirements of the WebVPL system design. Section 3 presents the overall system architecture and describes the functional components of the system. Section 4 discusses implementation issues. Section 5 describes a prototype of WebVPL and consolidates the implementation issues. Finally, Section 6 concludes the paper and describes our future work.

## 2 System Requirements

The main objective of WebVPL is to provide a general framework for Web-based access to programming lab facilities. We have carefully studied the requirements of