Chapter 2.23
An E-Learning System Based on the Top-Down Method and the Cellular Models

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ABSTRACT

As the broadband connectivity to the Internet becomes common, Web-based e-learning and distance learning have come to play the central roles for self-learning, where learners are given much flexibility in choosing the place and time to study. However, the learners still have to spend a lot of time before reaching the learning goal. This discourages the learner to continue their studies and diminishes their motivations. To overcome this problem and to let the learners keep focusing on their primary interests, we propose a top-down e-learning system called TDeLS. The TDeLS can offer learners the learning materials based on the top-down (i.e., goal-oriented) method, according to the learners' demands and purposes. Moreover, the TDeLS can distribute them to the learners through the Internet, and manage the database for learning materials. In order to share learning materials among learners through the Web, these learning materials are wrapped in XML with a specially designed vocabulary for TDeLS. We employed the cellular models that ensure the consistency among design modules and support a top-down design methodology. In this chapter,

we present the TDeLS for hardware logic design courses based on the cellular models. The primary goal is to design complex logic circuits in VerilogHDL which is an industrial-standard hardware description language. This chapter also presents the basic XML vocabulary designed to describe hardware modules efficiently, and a brief introduction to the structure and functions of the proposed system, which implements the TDeLS.

INTRODUCTION

We present a new top-down e-learning system (Abe, Yukita, & Kunii, 2003; Fujii et al., 2003; Fujii, Yukita, Koike, & Kunii, 2003) called TDeLS. The TDeLS provides the functions for dynamic and efficient retrieval of suitable learning materials across the network such as the Internet. It dynamically generates appropriate courseware according to the learner's needs, and assists the learner to achieve the learning target efficiently. Using the TDeLS equipped with these functions, students can keep focusing on their primary interests to achieve their goals successfully.

With the rapid progress of Web technologies, one of the most important requirements for an e-learning system is easy and efficient accessibility in the Semantic Web environment (Stojanovic, Staab, & Studiers, 2001). One solution is to represent the structure of courseware in some XML vocabularies. Furthermore, the top-down method is required for the efficient and robust development of the courseware. We adopt the cellular models (Kunii, 1999; Kunii & Kunii, 2001; Ohmori & Kunii, 2001; Yukita & Kunii, 2003) in order to ensure the consistency and also to maintain the conformance among the learning contents data. The contents are stored in the cellular database for efficient data link manipulation.

In a modern logic circuit design classroom, the use of hardware description languages (HDLs) is becoming very popular. They contribute to reduce both design effort and design time. With these HDLs we can share designed sub-circuit logic modules among learners and educators. However, without the help of such an e-learning system such as we propose, it would be very difficult to keep the learners' interests and motivations to lead them to the final goal. It would result in students' dropout before reaching the final goal. To show the effectiveness of our approach, we choose an example of courseware for the design of an 8 bits CPU (called TinyCPU) that processes four operation codes.

The TDeLS monitors the learner's achievements and navigates the learner. The learning material selection is determined based on the learner's skill, achievement, and degree of interest. Just selecting the learning materials is not sufficient. It is necessary to offer the learning materials in an appropriate order, which is expected to yield a better and shorter path to the goal. We show the algorithm for obtaining a much better order, and give an example of the generation of courseware for the top-down study.

This chapter is organized as follows:

- **Section 2:** We explain the top-down method, the cellular models and the cellular data structure.
- **Section 3:** We describe a common cell and the transformation of the cellular data into XML document are described.
- **Section 4:** The e-learning contents for hardware logic circuit design are described.
- **Section 5:** The transformation of VerilogHDL (The IEEE Verilog standard #1364, 2001) model into XML is described.
- **Section 6:** The structure of e-learning materials using the cellular models is shown.
- **Section 7:** We explain the courseware generation algorithm to generate learning contents and courseware.