Applying e-Environments in Teaching the Basics of Digital Logic

Tarmo Robal, Ahto Kalja
Tallinn University of Technology, Raja 15, 12618 Tallinn, Estonia
tarmo@pld.ttu.ee, ahto@cs.ioc.ee

Abstract

The development of the Internet has made it possible to move studies to e-environments, where time and distance are not obstacles any more. The paper presents an overview of an e-learning system and discusses some web-based tools for teaching the basics of digital logic in such a system.

1. Introduction

Our society has become largely dependent on information technology and computing systems. Although, we only seem to pay attention to it in case of system failures. Evidently, young system engineers should be educated with great care from the beginning, using different teaching methodologies, including e-learning and interactive tools, made available by the rapid development of the Internet and its associated technologies. The general practice among lecturers has been to use available tools or to develop their own systems for course management; resulting in a chaos. Obviously, a system containing all the courses the students are taking is in everybody’s best interest.

Hereby, we concentrate on an online learning services environment e-EDU [1], developed at Tallinn University of Technology (TUT), and tools being implemented for teaching the basics of digital logic.

2. Project e-EDU

The project was launched in 2002 with the aim to propose new and localized approach for daily and distance learning courses via providing essential support for students and lecturers in a service-based web environment and consequently enliven the ICT studies of the curricula of Computer and Systems Engineering, Electronics, and Informatics at TUT.

Today, e-EDU is being actively applied as the primary learning environment in 10 hard- and software related subjects with more than 1640 registered students. The design of e-EDU has followed the software development process proposed in [2] and is based on the modular kernel [3], enabling instant and flexible system expansion. The system is targeted to three user groups, each of them having a different interface and a set of tools. For students, a web portal edu.pld.ttu.ee has been established; the views for lecturers and administrators have been implemented within the department’s intranet.

3. Interactive tools and practical tasks

Teaching digital systems and logic is a complex area, where explanations should be accompanied by tools which clearly demonstrate the static knowledge in a dynamic form. Traditionally, students visit lectures, make notes and have some practical tasks to perform. The knowledge from the lectures is mainly represented by course materials and students’ notes, which are in a “lifeless” form. These notes may contain errors as well as misunderstandings. The motivation to learn from such materials may not be so high. Thus, we need to raise that motivation - learners should have the possibility to explore over and over again those scenarios demonstrated in the lectures. This can be accomplished with proper hands-on tools, where students can actually see what happens if they change something, hence learn by doing.

For first year students, we have accomplished a set of hands-on tools in e-EDU to introduce fundamental elements of digital logic with their behavior (Fig. 1), and problem solving using hardware. The elements in the tools include but are not limited to simple gates (e.g. OR, AND, MUX, DEC, adders, triggers, etc.).

Another set of tools is meant for demonstrating the practical tasks – how the input affects real-life situations. CAD-systems usually do not provide such a form of visualization. Therefore, we have found it to be justified to implement the real-life situations as simulators for our practical tasks. For example, a practical task where students have to develop a combinational circuit for controlling the segments on a display. Learners can change the inputs \( \{x_0, x_1, x_2, x_3\} \)
on the simulator and see the result. The combinational circuit is hidden as it is the piece of practical work students have to realize by themselves, to achieve the outcome shown on the tool. Such simulators bring the tasks closer to real-life situations, give students a better and clearer idea of the problems they are solving as well as enlivens the studies.

For advanced level courses, we already have a set of interactive tools for special SoC design in test related topics, as living pictures [4-6]. We are currently working on integrating those tools into e-EDU with retaining all the existing properties of their stand-alone mode. The integration will allow the simulators to be initiated within e-EDU with preset personalized tasks. In the future, we have planned to construct an ontology to automatically provide help and support for students using the simulator-tools for problem-solving.

Figure 1. D-latch. Students can set the input signals and let the tool to calculate the outputs, and vice versa.

4. Main advantages of applying the e-EDU

The implementation and exploitation of e-EDU, as an intelligent use of ICT towards e-supported courses and distance learning, has greatly affected the study process, in comparison to the preceding period. The e-EDU withholds a number of services [1,3] to support studies: (I) general services (e.g. student’s data, subjects and settings, e-Check-in, calendar), (II) course- specific services (e.g. personal assignments and progress, course materials, news, hands-on tools), and (III) additional services (e.g. account and quota information). These services have evolved over the years based on the experience of the staff and feedback from students, to improve the study process with the help of ICT, thus provide benefits for both.

Firstly, the courses are now on the Internet, leading to ubiquitous access. Secondly, all the information a student needs is gathered into a coherent environment, where everything is reproducible. For instance, a student gets an assignment on a paper and looses it, which happens quite a lot actually. Thirdly, the communication tools (news, feeds and forums) provide a convenient way to be always informed and discuss problems with others. Fourthly, students can get feedback and easily keep track on their progress with comments from the tutors. Fifthly, interactive game-like simulator tools enable to repeatedly explore the problems of a domain. Finally, in comparison to other e-learning environments, e-EDU has a native language interface, which is a clear advantage as not all of the students have studied English as their first or second foreign language.

Conclusions

The online learning environment e-EDU provides a new and localized approach to enliven daily studies as well as means for distance and e-learning. It assembles into one coherent environment all the essential services a student needs for studying, and lessens the workload of lecturers via tools for course management. Introducing game-like simulators for teaching the basics of digital logic in e-EDU, helps to make subjects clearer and thereby raises the interest towards the problematic areas of ICT in students – our future system engineers.

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References