E-LEARNING SYSTEM SYNTLOG

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ABSTRACT

The progress in the information technologies has impact not only in the area of computer sciences, but also in the area of education. The system SYNTLOG is e-learning system for synthesis and diagnostics of combinational and sequential logical circuits. This system is based on modularity; every module in e-learning part consists of theory and application program for given problem. The system is available by Internet and can be used by students at home or on other places. This paper presents main characteristics of this e-learning system, its utilization in educational process and also structure of individual parts of this system and references between modules of the system.

Keywords: *system SYNTLOG, e-learning, synthesis of logical circuits, diagnostics of logical circuits*

1. INTRODUCTION

The educational institutions are currently under pressure as they have to take effective steps to ensure that their students acquire knowledge which is necessary in the twenty-first century. One of the objectives of a modern educational institution is to make sure that their graduates are not only able to apply Information and communication technologies (ICT) in their future jobs on the basis of acquired ICT literacy but also that they are able to make use of these technologies as a tool and as an environment for the educational process itself. The current knowledge-based economy necessitates unprecedented flexibility of education, but also an effective offer of various options and solutions of knowledge acquisitions in various fields. The educational institutions cannot meet these tasks on the basis of classical forms of education only. Educational institutions all over the world started to integrate extensive resources available on internet and use internet environment also as an environment for education. In this way the internet environment is becoming a tool to increase the effectiveness of educational process administration and management.

Also the view of organization of the education process itself is changing and new methods and procedures are continuously introduced using the ICT as a major and suitable tool in the educational process. These new methods are in their essence different from the classical methods based on use of paper forms of educational materials. In general they presuppose wide use of various elements and components of educational process that enable to organize the educational process more effectively and they are frequently designated as "blended learning" with ICT playing an essential role within the high performance network infrastructures (most frequently designated as "e-learning"). Studies of this sort take place within the network environment that enables effective sharing of educational materials, administration and management of the educational process itself, assessment of the acquired knowledge and operative communication between teachers and their students. This means that the educational material is made available to students within the communication environment (mostly through the internet) and the students are organized in the virtual study groups – classes. They can study during their meetings in the premises of the educational institution coordinating the educational process, but also when and where it suits them best, as long as they have access to internet. If necessary the studies can be complemented by practical exercises in specialized classrooms and laboratories, by projects, case studies, presentations and consultations with tutors.

Educational materials and the organization of education may consist of multimedia presentations, simulations, combination animations, video, sound and text presentations, and last but not least, of the tests to verify the knowledge of students. Various Learning Management Systems (LMS) are used to provide specific managing functions of the education oriented in this way. The LMS frequently use also many other supporting features and functions, such as: chats, videoconferences, IP video-streaming solutions, application sharing, virtual class organization etc.

Experience with the use of ICT in education so far shows that the methods and tools of "e-learning" cannot be looked upon as a medicine to cure all problems related to education and these methods and tools can be fully replaced by classical methods of education relying upon ICT to much lesser extent. Surely the role of the teacher/educationalist remains significant and as a matter of fact this role will grow in its significance as the more effective the use of ICT in education and the better teachers/educationalists master these technologies, the higher will be the appreciation of their work they will receive. Therefore, the tools that enable the most effective communication and the requisite personal contact of the teacher and student independent of their location play more and more significant role in these new forms of education.

The means and tools of "e-learning" liberate the teacher from everyday repetitive reading in the class and at the same time, depending on the situation they enable the teacher to use various forms of information presentation to facilitate mastering of knowledge. E-learning enables the teachers to become tutors that pay attention to problem issues only, to improve their courses, to create new communication approaches with their students and to pay attention to other activities they had to neglect because of time pressure.

E-learning is wide notion, which describes utilization of information technologies in educational process. There are various definitions of the term e-learning [5]:

- instructions delivered via all electronic media including internet, audio/video, optical discs (e.g. DVD),
- learning facilitated by the internet and www technologies,
- distance education with utilization of the internet and other information technologies.

E-learning systems [6] are based on programmed learning principles. Programmed learning consists of self-administered and self-paced learning, in which students are presented with information in small steps. Each step contains a small segment of information to be learned.

Many of e-learning systems satisfy only some of basic educational principles and concentrate only on the passive getting of information, which can be presented by various forms. Some of systems consist of theory only other consist of theory and also practical tasks. Some form of interactivity is important.

There are various learning technologies [5] which determine how actual learning will take place depending on the environment in which they are implemented. These technologies include optical-media, learning management systems (LMS), content management systems (CMS), multimedia communities and virtual worlds, and game authoring technologies. Presented technologies facilitate communication and interactivity between students and teachers and also between students each other.

This paper presents e-learning system for synthesis and diagnostics of logical circuits (SYNTLOG), which is learning content management system and consists of theoretical description of solving problems and also application programs for solving of single phases of logical circuits synthesis and diagnostics.

Theory is widen by various animations, every application offers four modes, which allow automatic or stepwise computation, self-testing by a student and testing and evaluation in frame of educational process.

2. CHARACTERISTICS OF THE SYSTEM SYNTLOG

System SYNTLOG is a program system for synthesis and diagnostics of logical circuits. Internet application contents description of basic notion, theoretical principles and procedures from the area of synthesis and diagnostics of logical circuits. This system comprises also programs for solution of logical circuit synthesis and diagnostic tasks. These programs can run in automatic, demo, learning, and test mode. Thus this system represents complex virtual learning environment which offers many possibilities for learning and testing.

2.1. Didactic principles of the system SYNTLOG

The system SYNTLOG is based on modularity. Each module contains a theoretical description of a solving problem and a corresponding application. The theoretical description is divided into chapters, which include terms, facts, principles, rules, methods and explanation of an algorithm of a given phase. The theoretical description is implemented as www page (Fig. 1).

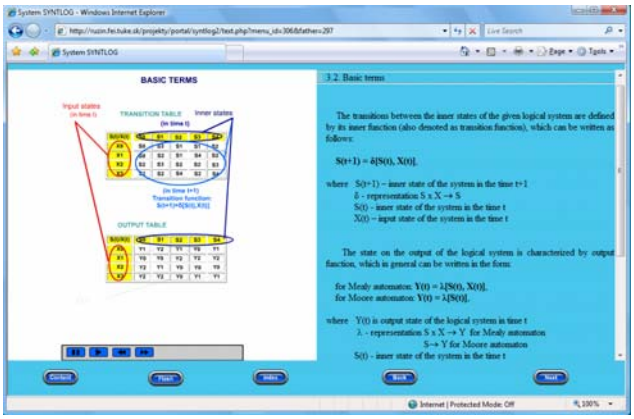

Fig. 1 The www page with theoretical description

The application program implements an algorithm of a given phase of the process of synthesis and diagnostics of logical circuits. Every application is implemented as a Java applet.

Applications in the system SYNTLOG work in four modes. In the automatic mode the input data are written in build-in editor or are loaded from an input file. Then the algorithm of the given stage is executed and results of execution are displayed. Results are saved into an output file, if it is required. Input and output files are text files so they can be written or changed using any text editor. The syntax of these files is simple and easy to understand. The output file of one program is the input file of another program (from another module), which realizes the next stage of the process of synthesis and diagnostics.

In the demonstrative mode an algorithm is executed step-by-step and every step is explained. The execution is stopped after each step to allow a student to see temporary results and a description of a step. The execution continues after clicking the “step“ button. Students can also skip one or more steps or terminate the execution. In the Fig. 2 an example of demonstrative mode of one module from the system SYNTLOG is presented.

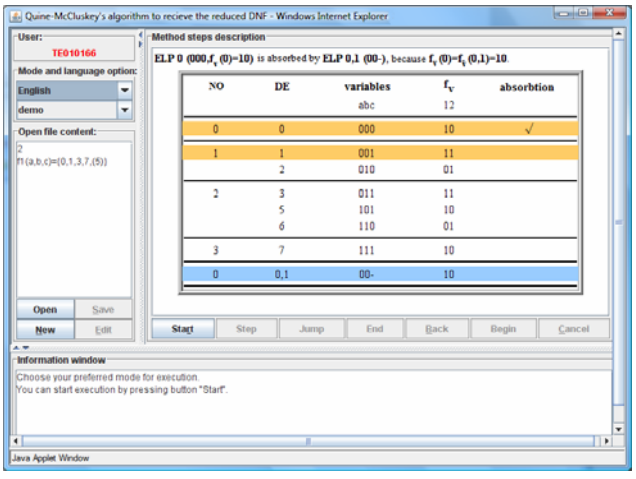

Fig. 2 The demonstrative mode of application program

In the learning mode students can test their knowledge about the given stage by answering the questions. There are two types of questions – theoretical and practical ones. Theoretical questions verify the knowledge of the curriculum. Practical questions verify the knowledge of an algorithm. These questions are put to a student during the execution of the algorithm – instead of the description there is a question after each step. When the answer is wrong the student can answer again. After three unsuccessful attempts the right answer is displayed. Students do not need to answer all questions – they can skip one or more questions. The results of the test (number of questions, number of right answers, time needed to answer the questions, etc.) are saved into the database. In the Fig. 3 an example of learning mode of one module from system SYNTLOG is presented.

The test mode is alike the learning mode but a student cannot correct the wrong answer and no question can be skipped. The questions are selected randomly so no students have the same questions. Results of given test are evaluated by the module for evaluation of results, which evaluates student knowledge about the given stage.

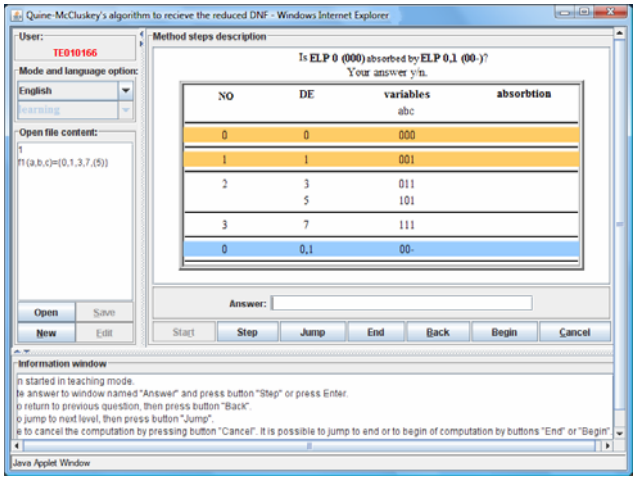

Fig. 3 The learning mode of application program

From the didactics point of view the application program is the most important part of the system SYNTLOG because of the last three modes. The demonstration mode allows passive receiving of information, the learning mode allows self-testing and thus it represents active form of learning, the test mode can be used for examination of students.

Questions in the test mode are based on principles such as validity, reliability and usability which are base principles of creation of didactic tests.

2.2. Utilization of the system SYNTLOG in educational process

The system SYNTLOG is utilized in educational process in Department of Computers and Informatics at Faculty of Electrical Engineering and Informatics, Technical University in Košice. This system is used as additional teaching material mainly for two subjects: Logical circuits and Diagnostics and reliability. System is dedicated for individual learning of students who attend these courses. Students can utilize required module for solving assigned tasks in frame of their course works.

In this time the system SYNTLOG is in test service so it is not used for examination of students. But there is a plan to use it for real examination.

3. PARTS OF THE SYSTEM SYNTLOG

The system SYNTLOG is divided into four main parts:

- student part – e-learning portal, which consists of theory and application programs
- content management system for the content of e-learning portal
- module for evaluation of test results
- user management system

Actually the system SYNTLOG is type of a learning content management system (LCMS), because it allows content management of training materials and also course administration. Therefore the student part is one main part and content and user management system create second main part of LCMS SYNTLOG. Student part is e-learning portal and administrative part is focused on course administration.

3.1. Student part

Student part is e-learning portal, which consists of various learning modules, which are divided into three main areas:

- synthesis of sequential logical circuits
- synthesis of combinational logical circuits
- diagnostics of logical circuits

Each module contains theoretical description of selected solving problem and an application program.

The theoretical description is divided into chapters to which we can access either sequential through the control buttons „next“ and „back“ or directly from the content. It comprises terms, facts, principles, rules, methods and explanation of the algorithm of the given phase. Definitions of various notions are explained in the notion index, to which lead links from the text of the theoretical description. The notion index is common for all modules. For better understanding of the theoretical description the text is integrated with the static figures and multimedia animations, which better explain some notions, principles and processes.

The display of theoretical description is divided into three areas: a text area, a visualization area, and a navigation bar.

The text area contains title and text of a chapter. The text includes links to the notion index and to multimedia resources (pictures, animations, etc.). The notion index is web page with alphabetically ordered definitions of terms used in the theoretical description and application programs.

In the visualization area the corresponding picture, animation or the notion index with definition of the corresponding term is displayed.

The navigation bar includes buttons „next“, „back“, “content”, “index” and “flash” for navigation through the chapters of the curriculum. These areas are depicted on the Fig. 1 in the subsection 2.1.

SYNTLOG Explorer is another important module, which allows students the access to the file system of the system SYNTLOG on the server side. So students can add new tasks from their computer file system for various modules in the system SYNTLOG also this way.

3.2. Content management system

This part of the system SYNTLOG is dedicated for management of the content of e-learning portal. The content is divided into modules. Every module contains particular theory, which is divided into chapters. It is possible to manage the content with editing chapter menu or editing chapter content. This chapter menu has tree structure. Edit chapter content possibility offers WYSIWYG (i.e. what you see is what you get) build-in editor, which allows comfortable editing of learning content. This editor allows also assigning various animations directly into the theory part as a link on selected text. After editing, data is stored into the database of the system. It is possible to assign application program in form of Java applet for every module.

Through this part it is possible also to manage content of theoretical questions in the test mode, or manage multimedia supplements in form of various animations, because it consists of links to these subparts of the content management part.

3.3. Module for evaluation of test results

Module for evaluation of test results is designated for evaluation of results from the test mode of application program from the student part. Test mode of every application program consists of ten questions, mostly four questions are theoretical, and remainder questions are practical tasks generated by given application program.

This module offers evaluation mechanism, which takes into account difficulty of assigned questions. Lector can review given statistics of evaluated results in individual categories of test questions.

Therefore instructor can find suspicious tasks, which are very easy or very difficult for students. There is possibility of making statistics for not only one student but also for a group of students (e.g. from similar class) or for students, who attend one of the courses in given time period.

Module for evaluation is interconnected to the module for administration of theoretical questions for the test mode, which allows inserting, editing and deleting questions for every application program. These questions are selected in random order and also answers (only one answer is true) for particular question are selected in random order. When a student finish the test mode, a lector can review also text of theoretical questions and answers, not only category, correctness or time of solving particular question.

3.4. User management system

The system SYNTLOG supports four groups of users with specific rights for content and user management as follows:

Administrator – is administrator of whole system, and has full rights over users, chapters or menu. There is only one user of this type.

Developer – is administrator of materials to be published. His rights are also unlimited except management of users.

Lector – after assigning rights by Administrator he has right as Developer except publishing approving.

Student – his rights are constrained only to the student part of the system. He has no rights to administrative part.

System SYNTLOG allows also anonymous access to the e-learning portal without possibility for realization of the test mode in application program.

4. REFERENCES BETWEEN MODULES

In the system SYNTLOG the essential phases of logical circuits' synthesis and diagnostics are solved. Whole process of the synthesis and diagnostics is divided into three sections:

1. synthesis of sequential logical circuits:
   - determination of abstract model in form of finite state automaton (Mealy or Moore) from system function given by regular expressions
   - states number reduction of the finite state automaton
   - optimal states coding
   - antiracing states coding
   - determination of exciting for elementary memory elements of type D, T, RS and JK and output functions of system
2. synthesis of combinational logical circuits:
   - determination of reduced disjunctive normal form (RDNF) by Quine-McCluskey algorithm
   - determination of irredundant disjunctive normal form (IDNF) by Quine-McCluskey algorithm
   - determination of IDNF by Petrick method
   - determination of IDNF by Zissos-Duncan method
   - creation the Three level And-Not logic with True inputs
   - factorization of the algebraic expression
   - transformation of the algebraic expression from Boolean to Sheffer or Peirce algebra
   - creation of the logical circuit structure scheme
3. diagnostics of logical circuits:
   - determination of combinational circuits test by
     - D-algorithm
     - B-differentiation
   - critical path
   - determination of independent localization test including the fault dictionary
   - determination of dependent localization test including the localization tree
   - design of easy testable circuits

These modules are connected together through the file system of the system SYNTLOG, thus they can communicate each other (Fig. 4). Modules have possibility for inserting or loading input data, so every module can be used also separately.

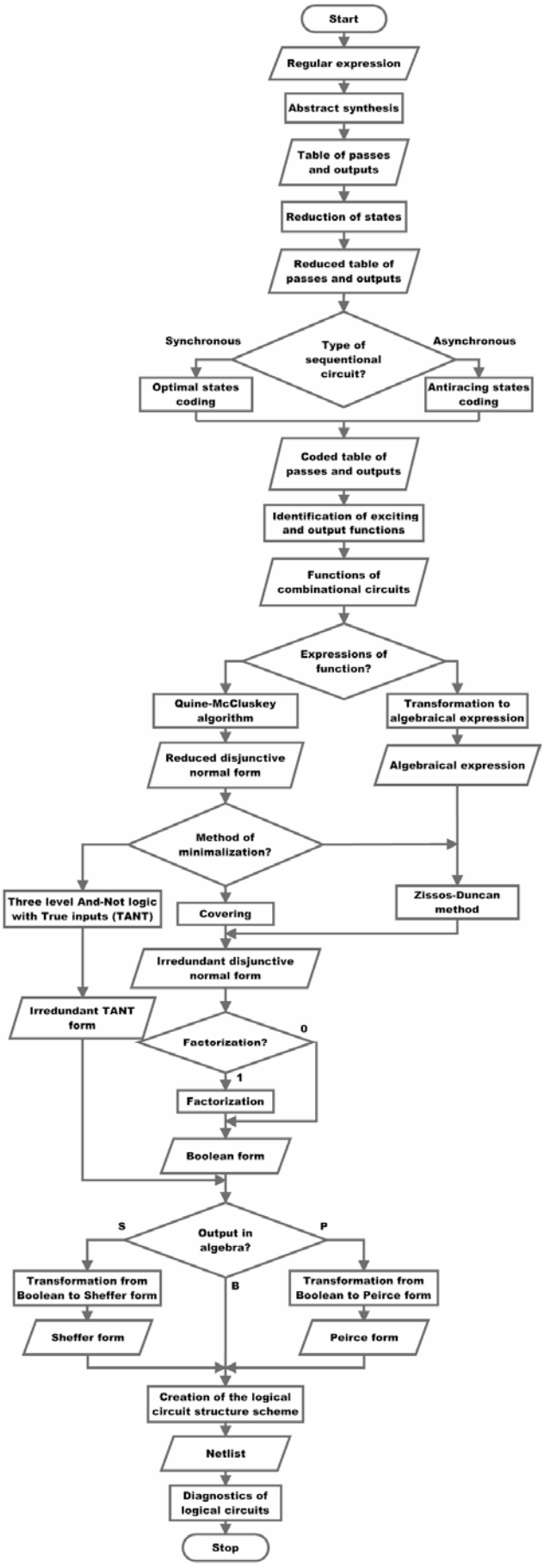

Fig. 4 Block structure of program system SYNTLOG

5. CONCLUSIONS

The system SYNTLOG is specific e-learning system dedicated to the area of synthesis and diagnostics of logical systems. Its essence is in utilization of applets for realization of algorithms for individual phases of synthesis and diagnostics. In addition to the automatic mode, these applets can be used also in the demonstrative, the learning and the test mode, in which selected algorithm is executed in logically ordered steps. These steps are added with explanatory comments and/or questions with purpose for understanding of an algorithm or examination of students' knowledge.

Although the system SYNTLOG is specific, principles, on which it is based, can be used also for other areas, which are focused on understanding of algorithms. Another advantage of the system SYNTLOG is possibility of demonstration of computation on arbitrary examples of adequate complexity not only demonstration on limited groups of examples.

In addition to applets, the system SYNTLOG consists of theoretical description of solving problems. This description is added with pictures and spoken animations, which facilitate understanding of functionality of selected algorithms.

The system SYNTLOG has also its own content management system for preparation of materials, which facilitates addition of new modules, applets or explanation texts with theory, editing, processing and integration of text, pictures, animations, and insertion of theoretical questions. Another part of the system SYNTLOG is its user management system, which allows registration and authentication of users, assignment of students to teachers and so on. In comparison with other universal e-learning systems [7] such as BlackBoard, Moodle, ATutor, etc., the system SYNTLOG does not have so far its own possibility for communication between students and teachers.

For the purpose of evaluation of students' knowledge, the system SYNTLOG has a database with results of performed tests from the learning and the test mode, which allows evaluation not only according to individual students but also according to individual questions. This possibility allows a teacher to find out, which question is answered insufficiently and make relevant changes in the part, which explains given question, eventually to change point assessment of given questions.

Another system from the area of logical circuits which is related to the system SYNTLOG is an e-learning environment, developed at Tallinn Technical University [4], which consists of several parts. One of the parts consists of Java applets on various aspects of decomposition and test of digital systems.

The system SYNTLOG is now in development, new modules are programmed and functionality of some of old modules is gradually improved due to improvement effort of educational process. There is also effort for an interconnection of the e-learning modules to the various hardware devices in the Laboratory of computer engineering. Another detailed information about the system SYNTLOG is presented e.g. in [1, 2, 3].

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BIOGRAPHIES

Ján Bača (doc, Ing, CSc) was born in 1947. He received the Ing (Msc) and CSc (PhD) degrees from the Faculty of Electrical Engineering, Slovak University of Technology, in 1968 and 1982 respectively. Since the 1969 he has been employed at the Technical University in Košice, since 1985 as Associate Professor at the Department of Computers and Informatics, Faculty of Electrical Engineering and Informatics, Technical University in Košice. His current teaching and research interests are oriented towards design and diagnostics of logic circuits, computer nets, CAD systems, formal specifications and decomposition of systems.

Michal Forgáč (Ing.) was born in 1983. In 2006 he graduated at Technical university of Košice. He is working on his PhD. degree at the Department of Computers and Informatics FEEI, Technical university of Košice. His scientific research is focused on the aspect-oriented programming paradigm, software evolution and adaptiveness of complex software systems.

František Jakab (Ing., PhD.) was born in 1959. He received the MSc. degree in Systemotechnic engineering from the St. Petersburg Electrotechnical Institute (Russia) in 1984 and the PhD. degree in 2005. He is employed as an assistant professor at the Dept. of Computers and Informatics, Technical university of Kosice, Slovakia. He is a head of the Computer Networks Laboratory (www.cnl.tuke.sk). His research interests include projecting of computer network, modelling, simulation and network management, new form of multimedia-based communication, QoS, telelearning systems & intelligent tutoring systems. He has been a coordinator of several large international e-learning oriented projects supported by EC. He is a coordinator of the Cisco Networking Academy Program for the Slovak Republic and head of the Application Section of the Communication Technology Forum Association in Slovakia.