COMPUTER SUPPORTED TEACHING IN THE THEORY OF ELECTRICAL ENGINEERING

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Abstract *¾ The paper deals with the computer software system, which supports the teaching of the Theory of Electrical Engineering – TEE (it involves two disciplines – Circuits Theory and Theory of Electromagnetic Field). The study of the theoretical disciplines in the Electrical Engineering education requires a deep understanding of the physical fundamentals of electromagnetic phenomena and the behaviour of electric systems. The development of independent creative students' activities and abilities to apply the obtained knowledge to the solving of simple technical problems represents a very important part of teaching. To achieve such experience students work out 2-3 term papers in each course. However, to set, check and evaluate these tasks is very time demanding for teachers. On this account, a computer software system was suggested and realised. This system enables settings, checkings and evaluations of term papers by means of computers which are connected to Internet. Our project is based on the WWW server Apache and the database server, which is realised by means of the mySQL system. The professional program package MATLAB with toolboxes MATLAB WEB server and MATLAB Database toolbox have been used. All these program packages run under LINUX operating system environment.*

Index Terms ¾ Education of Electrical Engineering, MATLAB Web Server, usage of Internet in education

INTRODUCTION

The courses of Circuits Theory (CT) and Theory of Electromagnetic Field (TEMF) represent basic theoretical subjects concerning the studies of Electrical Engineering. The main features of teaching CT and TEMF are expressed as follows:

- introduction of the fundamental concepts and qualities, the explanation of physical nature of electromagnetic phenomena and electric systems behaviour ***(formulation of the problem)***
- explanation of the basic laws with their mathematical formulation ***(mathematical model of the problem)***
- explanation of the methods used for solving of electrical problems including the physical interpretation and the discussion of the obtained results

The classic way of teaching of these theoretical subjects requires good knowledge of mathematics and sufficient experience in different mathematical modifications. More attention is paid to analytical or numerical calculations than to the studying of properties and behaviour of the investigated systems. The basic disadvantage of the classic way not using computers is manifested in a multitude of routine activities, which are detrimental to the development of the engineer way of thinking. Less time is dedicated to the understanding of physical fundamentals of researching phenomena. Moreover, it is usually possible to solve the considerably simplified tasks that represent a rough approximation to the real technical problems. The usage of modern computers, networks, Internet and software can help to eliminate this problem. In paper [1], [2] and [3] the program of teaching CT and TEMF that reduces laborious mathematical calculations and replaces them by an interactive work with computers, which has features of an experimental activity, was suggested. The teaching CT and TEMF was supplemented by the usage of professional program packages such as PSpice, QuickField, etc. In this paper another manner of using computers will be described.

The development of independent creative students´ activities and abilities to correctly analyse simple technical problems and apply the obtained knowledge to their solving represents a very important part of teaching CT and TEMF. In each course, to achieve such experience, students are to work out 2–3 term papers in which they are to solve simple technical tasks. Settings, checkings and evaluations are very time demanding for teachers. Moreover, students cannot discuss their problems and questions immediately. They have to wait until the next lesson. On this account, an interactive computer software system was suggested and realised. This system enables settings, checkings and evaluations of term papers by means of computers, which are connected to Internet.

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COMPUTER SW SYSTEM

The suggested system uses the web-based user interface. This project is based on the WWW server Apache and the database server is realised by means of the mySQL system. Programs (in the PHP language) generate the WWW pages. All these packages belong to the Open Source Software. Commercial software packages were also used – MATLAB (the language/system of technical computing) with toolboxes – MATLAB WEB server and MATLAB Database toolbox. All these software packages run under RED HAT Linux 7.2 operating system environment (Fig. 1).

The database that was created on the server includes the information about students and tasks. The system communicates with the users (students and teachers) through a WWW browser and enables settings, checkings and evaluations of students' term papers.

The system generates (on demand of the WWW user interface) the setting of student's term paper, which is based on the random selection from given interval and / or the random selection from given sets of possible settings. Subsequently calculations of settings are effectuated and the results are saved into the database (using MATLAB Database Toolbox).

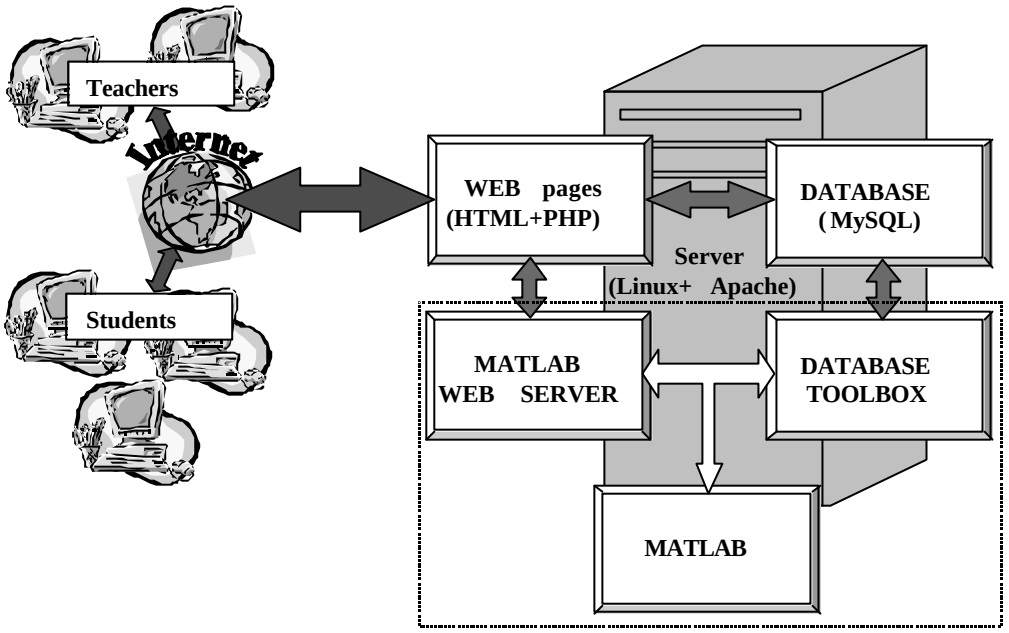

FIGURE 1
SYSTEM SCHEME (SIMPLIFIED)

Teachers can supervise students' results in the database using this web based user interface. System administration is also realised in this way. Thanks to the usage of this user interface, workstations are able to operate on any platform and can be anywhere on Internet.

This system is also used for presentations of case studies (*e*Learning) using MATLAB Web Server. Examples from the branch of Theory of Electrical Engineering are storage on server in form of m-files. These m-files are used by MATLAB Web Server and enable students a tutorial in form of web pages that are available to each computer which is connected to Internet (obviously using a web browser). Students can send various input values for the computation by means of web forms. MATLAB Web server shows them results in form of WWW pages, which do not only include text or numerical values, but also graphs, diagrams, charts, schemes, plots, i.e. generally – pictures. Our system offers sending (using web forms) of questions to teachers. These questions are saved in the database, answered by teachers (using web forms, again) and presented, via web pages, back to students.

Application functionality

Creating a course – saving into the database: unique ID of course, department name, abbreviation of course name, course name.
Creating a new task – saving of m-file and task's description into the dedicated server's directory.
Setting a new task – is generated on demand of the student using a WWW browser and is based on a random selection from given interval and / or a random selection from given sets of possible settings.

Computing a task – every night, Linux daemon `cron` runs MATLAB script, which computes the task for each student and save results into the database.
Checking results – the student enters his results (using web form) and the system saves it into the database. The system shows to the student whether the results are correct or incorrect in the form of a web page.
List of student's checking of results – enables teachers to see how many times a student checked his results and how many of term papers have been already turned in.
List of tasks – lists all tasks in the database, enables editing of task and task description, shows the list of students who are to submit these tasks and shows their results.
List of Courses – lists all courses in the database, the authorised user can edit or create a new course, enables to see the list of students attending the course.
Deleting tasks – deletes the task from the database (with regard to the database integrity).
Deleting courses – deletes the course from the database (with regard to the database integrity).
Viewing log files – views all log files (errorlogs).
Creating a new database
Changing academic year – reviews old data.

Application User rights

Students – generating the setting of a new task, checking results, changing password.
Teachers – student rights + list of student's checking of results, list of tasks, list of courses, deleting tasks, changing academic year etc.
Low administrator – teacher rights + changing usernames, editing users (first name, second name, password, change of courses, tasks and task descriptions, viewing logs and errorlogs).
Administrator – full administrator privileges i.e. low administrator + creating a course, creating a new task, deleting all tasks, deleting courses, creating a new database.

Communication security client / server

The application uses the Secure Sockets Layer (SSL) to secure data communication between a server and a client system (module `mod_ssl` of APACHE server). The SSL communication is supported by the majority of web browsers.

HARDWARE

The hardware configuration is composed of two Pentium III processors, four hard disks 80 GB (RAID 0+1), 2 GB RAM, a tape backup recorder and an Uninterruptible Power Supply APC Smart UPS 1000 VA.

This hardware configuration is sufficiently proportioned for the supposed usage. We tested this system on the platform Intel PIII 600Mhz, 128MB RAM. The test database contained 2008 tables, 796400 records and the database size was 341 MB. In real operating we assume only about 10% of these values.

Database `select` operation over 5000 records took about 23 seconds and the transfer and displaying of the final web page about 70 seconds because the size of final HTML was 4,6 MB. In case of the real database size, the same `select` operation takes only 2 seconds and transfer only 3 seconds.

CONCLUSION

The aim of the paper is to remind of the fact that the modern computer technology in common with powerful SW allows to considerably changing the way of teaching of CT and TEMF. It reduces laborious mathematical calculations and replaces them by an interactive work with the computer, which has features of an experimental activity. This is the basis for opening a space for increasing a part of the independent and creative students' activity.

In this paper was described a system using Internet and MATLAB Web Server for student's independent work. The main advantage of the selected software system is its simplicity, universality, relatively low cost and easy expansion. The use of this system is not designed for teaching of the theory of electrical engineering only but also for teaching of mathematics and other technical disciplines. We believe that besides providing students the help to develop their technical thinking and creativity our system can also help to simplify the work of teachers, which results in increasing the effectiveness of the whole educational process.

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