

Design and Development of a Web-based Engineering Graphics Exercise System

Liping Huang ^a, Jicong Zhao

Department of Mechanical Engineering, Tsinghua University, Beijing, 100084, China.

^ahuanglp@tsinghua.edu.cn

Keywords: engineering graphics; teaching resource; education reform; mobile education.

Abstract. With the highly development of computer network technology, in order to improve the enthusiasm of students' autonomous learning and promote the teaching pattern to student-centered, in this paper, the inform of engineering graphics assignments training (EGAT) mode is explored and the development technology of a Web-based Engineering Graphics Exercise System (Web-EGES) is researched to solve the problem of training pattern being too monotonous. Firstly, this paper proposes the new mode of engineering graphics assignment training, which integrates manual drawing training, drawing with Computer Aided Design (CAD) software and online assignment training. Secondly, the Web-EGES is established based on browser/server (B/S) structure and the function modules of the system are designed. Finally, the multi-layers system architecture of Web-EGES is established and the implementation technology based on the Python and Django is presented. The System provides exercise database, answer database and 3D model database, which could be dynamic extended and updated. It is very convenient for teachers and students to connect to the Internet to use the system with desktop computers and mobile devices, such as smart phones and tablet computers.

1. Introduction

In colleges and universities, engineering graphics course is an important technical basic course of cultivating students' engineering quality. It is necessary to cultivate engineering undergraduates' ability of reading and drawing engineering drawings through assignment training. Currently, most of the training forms are a traditional practice, of which students are required to draw a large number of manual drawings on exercise books, and then teachers carry out manual correction. This kind of training mode has some shortcomings, such as monotonous form of homework, heavy burden on teachers and students, etc. A large number of repetitive, monotonous manual drawing homework is easy to make students tired of work so that it is not conducive to effectively arouse the enthusiasm of students to learn actively. Therefore, it is necessary to reform traditional assignment pattern and to establish a new model of engineering graphics assignment training. Aims to the diversification of school assignment types, a new efficient way of training must be designed and a web-based engineering graphics exercise system must be developed to help to improve the efficiency of learning and teaching resources sharing.

In extracurricular teaching practice and teaching software system development, some progress has been made. An Interactive multimedia CD-ROM [1] is provided for student learning. Some assignment systems [2-4] have been developed based on Client/Server(C/S) or B/S structure. But, there are some problems, such as some applications need client installation, some systems do not support extended in using, some applications do not support wireless mobile devices to use. With the development of the web2.0, cloud computing and online teaching, MOOC [5] presented the explosive growth in a number of platforms with online course teaching. It is becoming a kind of tendency that students through the browser watch the video, learn courses and complete the corresponding exercises at the same time. Therefore, a lot more teaching resources are needed, which can be integrated on the Internet platform for sharing.

In this paper, we will present a new assignment training mode of engineering graphics course under this new situation and build a web-based engineering graphics exercise system. The functional

modules of the system are proposed and the implementation technology that is based on the Python programming language and the Django web framework is presented.

2. The New Mode of EGAT

With the rapid development of information technology, the university courses also require corresponding reform. Some old traditional teaching method must be changed to adapt to the times. For engineering graphics course, under the old model, students have to do much repetitive homework so that the learning efficiency is low. Therefore, it is very significant to optimize the content of assignment and establish a new mode. The new mode should streamline the repetitive work and provide some new training method.

Under the background of modern product development, students must possess the ability of reading and drawing engineering drawings, not only the manual drawing ability, but also the ability of using computer software for drawing. Consequently, the trainings of manual drawing (MD) and computer drawing (CD) are both necessary. But, the completion time of MD is too long, resulting in low learning efficiency. However, from reducing the burden on students, the amount of MD exercise should be decreased, instead of increasing reading drawings (RD) exercise of consuming less time. While the latter is very suitable for using database to manage and utilize on the Internet, named online assignment (OA).

Therefore, the new mode of EGAT is composed of three parts, which are manual drawing, computer drawing and online assignment.

The three parts of the assignment training are described as below:

MD assignment: It aims to training the students' ability of drawing. It includes two ways of drawing, one is drawing with ruler and compasses, and the other is freehand sketch. The former is the main and the latter is auxiliary.

Online assignment: Aims to training the students' ability of graphic thinking and projection method analysis. It is necessary to establish an exercise database, which includes two types of questions: multiple choice and judgment questions. All kinds of questions are managed by the Web-EGES.

CD assignment: Aims to training students' ability to use CAD software for drawing. For example, using AutoCAD software to draw 2-dimensional (2D) engineering drawing and using Solid works software to establish 3D model of parts, and then transfer 3D model into 2D engineering drawing, etc.

Currently, MD assignment and CD assignment are applied well, but for OA, the support of an information management system is very necessary. Therefore, it is imperative to develop the Web-EGES.

3. The Functions of the Web-EGES

According to the different roles such as teachers, students and administrators, the Web-EGES provides different function configurations.

The system adopts modular structure to accomplish multiple functions, such as exercise classification, exercise database management, students' information management, assignment management, automatic correcting function, performance analysis and statistics, students' self-training function, etc.

The function modules of the Web-EGES include resource management module, knowledge tree management module, assignment management module, score management module, students information management module and system management module, etc.

1) Resource Management Module: It provides the management function of exercise database, answer database and 3D model database, including establishment, editing, maintenance and dynamic extension of each database.

2) Knowledge tree management module: Knowledge tree is a hierarchical tree structure that is composed of each knowledge topic of engineering graphics course. The module provides not only establishment and modify the tree of knowledge dynamically, but also the correlation relationship between the nodes on knowledge tree and instances in database.

3) Assignment management module: It includes teachers' functions and students' functions. The functions that are provided to the teachers include giving homework assignment and automatic check homework assignments and the functions that is provided to the students include the process management of students doing and submitting their homework, viewing answer and models and viewing correct answer and models, and self-determination exercise, etc.

4) Score management module: It provides different functions for teachers and students, including performance distribution analysis, accuracy analysis, difficulty analysis, error statistics, record export and score viewing, etc.

5) Students information management module: It provides teachers with class list automatically checked in, viewing and editing functions, etc.

6) System management module: It includes people management, maintenance of database and system.

4. Development of the Web-EGES

4.1 The System Architecture of the Web-EGES.

The Web-EGES is established based on B/S structure. The system provides the web services for the engineering graphics course, which supports teachers and students to connect to the system with computers and mobile devices, such as mobile phones and tablet computers at anytime and anywhere.

The Architecture of Web-EGES is shown in Fig.1. The system consists of five layers: Web Browser, Web Server, function layer (application server), data layer (database server) and support layer. Some main layers are described below:

1) Function layer provides application functional services, including resource management service, knowledge tree management service, assignment management service, score management service, student information management service and System management service and so on. It provides application functional services for users in network environment. Users have been divided into three

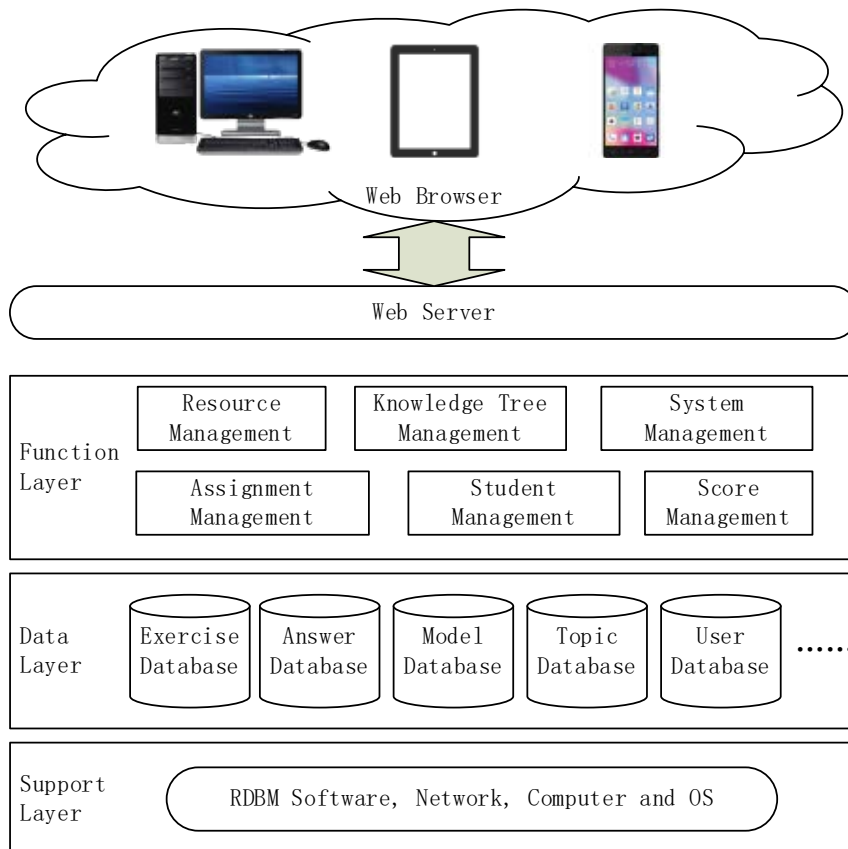


Fig.1 System architecture of the Web-EGES

Groups: teachers, students and system administrator. According to different users, the system provides different functional services.

2) Data layer is composed of all data object. Some data object should be classified and stored in different databases and the other, such as graphic data or image file is stored in the file system. The system's databases include exercise database, answer database, model database, knowledge topic database, user database, etc.

3) Support layer includes software and hardware foundation environment, such as Relation Database Management System (RDBS) software, network, computer and Operator System (OS).

4.2 Implement of the Web-EGES.

The Web-EGES is developed on Python (2.7) programming language and Django web framework.

Python is an object-oriented, interpreted computer programming language, being invented in 1989 by Guido van Rossum. It has often been nicknamed glue language, which can make various modules in other languages easily join together.

Django is an open-resource web application framework, using Model-View-Controller (MVC) method. Its primary goal is to ease the creation of complex database-driven websites. Currently, Django becomes one of the most popular web frameworks for web rapid development. The technology route of the Web-EGES based on Django is shown in Fig. 2. Firstly, users visit system by

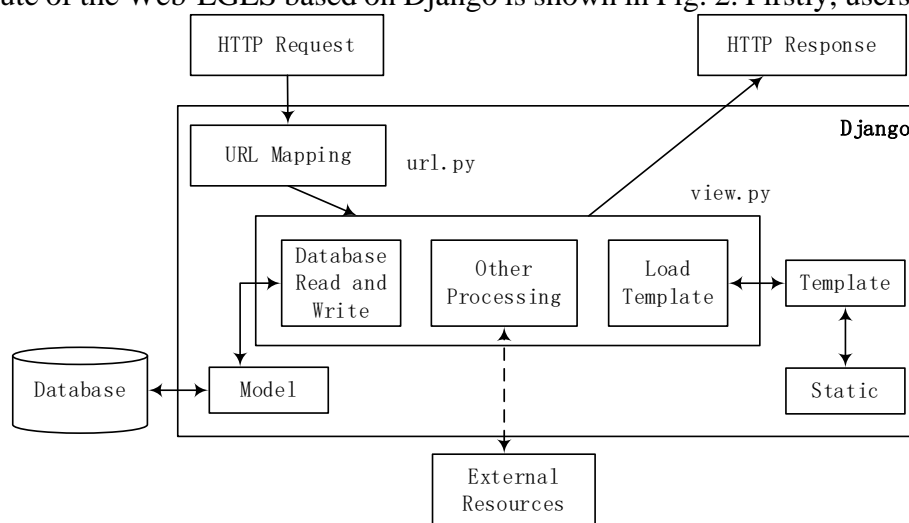


Fig. 2 Technology route of the Web-EGES based on Django

Sending the http request. Url.py file has URL mapping function that passes the users' requests to the corresponding functions in view.py file. Then, in view.py file, features such as database reading and writing, loading template and other processing can be realized. In Django, reading or writing database just through model that is convenient to system developers. Web pages are based on template that developers can pass data to the template and templates translate the data to well-displayed forms. Finally, functions in view.py return http response to the web browser to users.

5. Conclusion

In order to promote the teaching mode to the students as the center, this paper proposes the new mode of engineering graphics assignments training for strengthening network education and has designed a web-based assignment training system. The implementation of the Web-EGES will help to reduce the burden of teachers and students and improve students' learning interest and efficiency. Beneficial exploration will be made in the aspect of network education and mobile education. The system will be further studied in the aspects of data analysis and student self-Learning.

Acknowledgments

The research is supported by Tsinghua University Teaching Reform Program (ZY01-02).

References

- [1] D. K. Lieu. Using Interactive Multimedia Computer Tutorials for Engineering Graphics Education. *Journal for Geometry & Graphics*. Vol. 3 (1999) No. 1, p. 85-91.
- [2] C. Jimenez. A Media-Based Engineering Design Teaching Tool: MIT's EDICS. American Society for Engineering Education New England Section Annual Conference. Worcester, MA, March 17-18, 2006, p. 1-15.
- [3] LI Zhe-lin, CHEN Jin-chang, LIU Jin-nu, et al. Engineering Drawing Networked Exercise Book and Correction System. *Journal of Engineering Graphics*. Vol. 25 (2004) No. 4, p. 154-158. In Chinese.
- [4] LU Zhang-ping, LIU Ai-ping, DAI Li-ling. The Design and Realiation of Engineering Graphics Networked Exercise System Based on JAVA. *Journal of Engineering Graphics*. Vol. 26 (2005) No. 1, p. 107-112. 、 In Chinese.
- [5] J. Kay, P. Reimann, E. Diebold, et al. MOOCs: So Many Learners, So Much Potential. *Intelligent Systems IEEE*. Vol. 28 (2013) No. 3, p. 70-77.