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AI-Based Teaching Package for Open Channel Flow on Internet

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Abstract. During the past decade, the trend to couple the World Wide Web (WWW) in teaching and learning has been gaining momentum rapidly. Learning availability over the Internet is expanding and gradually constitutes a usual means of education and training. In this paper, the development and implementation of an AI-based interactive teaching package for open channel flow on Internet is depicted. The latest expert system shell and web production software are used for the development of this system. It is demonstrated that various theories on open channel flow, design, and interactive "What-if" analysis on various design parameters can be performed using this package through an active and dynamic learning environment. It is shown that, with its intrinsic advantages, the WWW has the potential for effecting fundamental changes in the design of learning processes and the education system.

1 Introduction

Within the prevalent educational systems and amongst the population of students that these systems serve, quite a wide ranges and variations among students can be detected. Moreover, the current demand for higher education at different age groups has been increased, particularly in adult age group. There exists a trend that the society increasingly requires people of better educational quality so as to enhance the productivity. Hence if the adults desire to earn more to improve living conditions, they have to upgrade themselves through various channels. But time constraints and places where they were living usually impeded them [1]. Furthermore, the traditional teaching system offers no facility in tracking student's progress or keeping courseware up to date. It is not enough just to supply materials to the students. In order to overcome these problems, new teaching paradigm is entailed.

Nowadays, the society has entered into the information age. The linked material in Internet could be in a variety of formats including picture, sound, video, 3-D modeling, animation or application. As a result of technological advancements in the fields of computer technology, artificial intelligence technology, education and instructional technology, web-based learning (WBL) has been becoming somewhat common place traditional higher educational settings [2]. Many schools try to conduct a minimum of some types of web-based instruction. WBL provides a flexible and cost-effective means and opportunity of access to lifelong educational opportunities

and allows people work at their own pace from different locations. The web-based interactive system, which provides the opportunity for interaction from the learners, allows a student to dip-in and dip-out of the different course sections and allows progresses of students to be monitored and recorded. WBL has also been used in some organizations so as to raise the effectiveness of their education and training operations for the ultimate goal in enhancing the productivity.

Moreover, a knowledge-based system (KBS) has been demonstrated to have the capability of encapsulating systematically the heuristic expertise and knowledge. Successful applications of KBS have been undertaken in different fields including interpretation; design; diagnosis; education; and planning [3-20]. In this study, an AI-based interactive teaching package for open channel flow on Internet is developed and implemented, by employing the latest KBS technology and web production software. By using custom-built interactive graphical user interfaces, it is able to assist learners by furnishing with knowledge in this domain.

2 Web-Based Tools

Recently, the rapid development of the internet-based learning from a text-only medium to an expanding multimedia communication system has increased and diversified delivery mechanisms of quality education. Internet-based learning tools that are commonly used include e-mail, listservs, web-based bulletin boards, chat, online courses, electronic performance support system, static web pages and interactive web pages. The numbers of items to be added on the web page depend on the expected requirement of the users. Among them, it is worthwhile to emphasize the interactive web pages since they include the ability to search a database, ask questions, customize the look and feel of the site, and perform other types of interaction and online web-based course. It is noted that the interactive web pages are still not yet as common as static web pages, yet the number of sites deploying interactive web pages continue to grow.

3 Developing Environment and Tools

It is not easy to compile an ideal web page if one is just using single web design software to create a web site. As such, in this case, several professional software are employed. Moreover, artificial intelligence techniques have been incorporated in the design of the underlying WBL framework.

3.1 KBS Shell with Blackboard Architecture

In order to facilitate development of the knowledge base on open channel flow, expert system shell containing specific representation methods and inference mechanisms is employed. This system has been implemented with the aid of a microcomputer KBS shell Visual Rule Studio, which is a hybrid application development tool under

object-oriented design environment. This shell acts as an ActiveX Designer under the Microsoft Visual Basic 6.0 programming environment. In addition, Visual Rule Studio is compatible with Active Server Pages and Microsoft Internet Information Server. The ruleset components can be deployed as part of a web server based application so that, with a web browser and Intranet or Internet access, it may virtually reach any users.
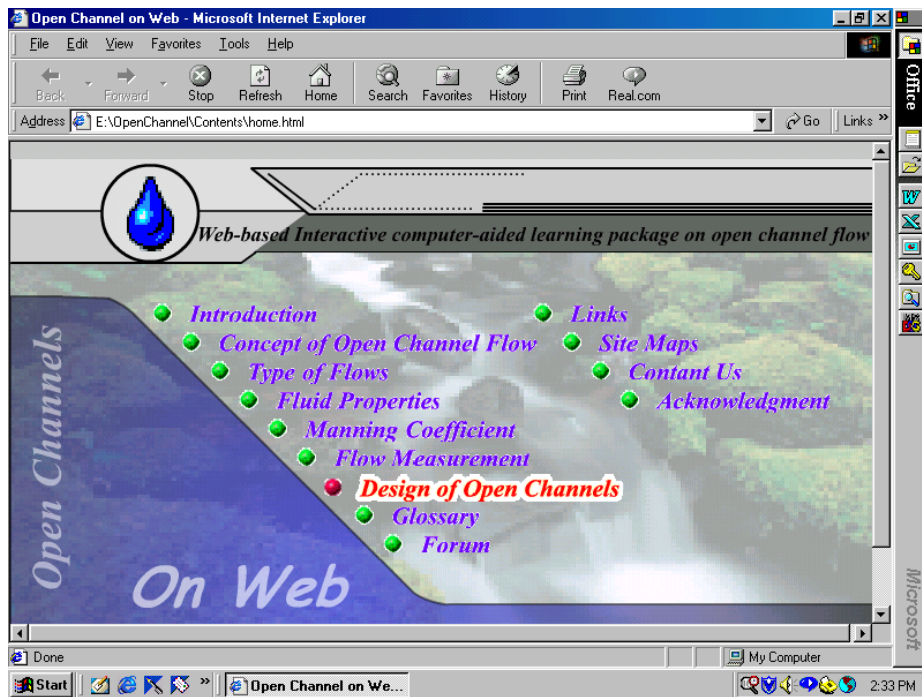

Fig. 1. Screen displaying the opening menu of the computer-aided learning package on open channel flow

Blackboard architecture has been developed to furnish a problem-solving model with contribution from a multitude of knowledge sources at different levels by integration into a single system [21]. A variety of specialized expertise or knowledge sources are grouped into separate modules by employing both rules and frames and, sometimes under object-oriented programming environment. Blackboard system encapsulates information sharing through the common data structure called a blackboard, which compiles the data entries as well as acts as the communication link among various knowledge sources. The blackboard acts as the global system context, which stores the current state of the solution, including problem data, intermediate parameters and final outputs of the design. Both production rules and procedural methods are employed to represent standard and heuristic knowledge on fluid mechanics. Rules are isolated as component objects, which are separated from both objects and application logic. Rule development becomes a natural part of the

component architecture development process. Under the declarative knowledge representation environment, objects are used to encapsulate knowledge structure, procedures, and values. Object behavior is tightly bound to attributes in the form of facets, methods, rules, and demons. By defining various types of windows as different classes, such as Check Box, Option Button, List Box, Command Button, Text Box, etc., they can inherit common characteristics and possess their own special properties.

3.2   Web-Development Tools

The frames of the web pages are built by using the software Dreamweaver. Java programs are employed to illustrate interactive open channel design calculations. It provides different combinations of variables in the governing equations for users to design their own channels. JavaScript is used in the search function to provide multiple web site searching so that the user can easily select the web site from the pull down menu. Moreover, it is used to add some functions such as the timer in the web page. Flash is used to effect the animation effects in the home index of the package, making the web page more active and alive. Photoshop is employed to edit all the pictures and graphics in the web page of the package. PhotoImpact is used to perform some special effects in the pictures.
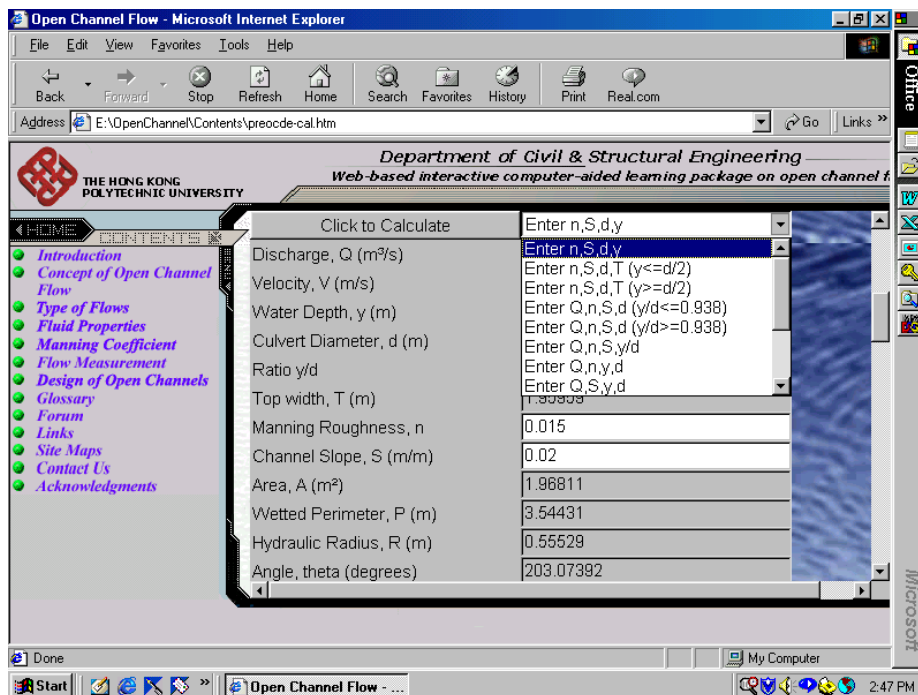

Fig. 2. Screen displaying interactive analysis of circular culvert that can demonstrate the effect of variation of various design parameters on the result

4 Interactive Teaching Package

Broadly speaking, the web pages are grouped into three parts. The first part provides the basic concept of open channel flow [22] to the users, which is a one-way information transfer from the webmaster to the users. The second part provides some design exercises and interactive "What-if" analysis about open channel flow for the users to test how they understand the domain topic, which is a two-way information transfer. The final part provides some functions to allow the users more direct contacts with the application designer through sending electronic message and the other users through discussion forum. Figure 1 displays the opening menu of the computer-aided teaching package on open channel flow. The structures of the web pages are divided into thirteen headings which include introduction, concept of open channel flow, type of flow, fluid properties, Manning coefficient, flow measurement, design of open channels, glossary, forum, links, site map, contact us, and acknowledgments.

The introduction section outlines the basic characteristics of open channel flow. The classification of open channel into either natural or artificial channel is then explained. The section on concept of open channel flow is divided into four sub-headings, namely, general approach, energy principle, velocity distribution, and hydraulic jump. It covers the assumptions taken and the derivation of the governing equations. Under the section on type of flow, the basic concepts of uniform flow and gradually varied flow are articulated. The section on fluid properties shows the general properties of the fluid and summarizes the common values of various fluid properties. The section on Manning coefficient gives the roughness properties of the channel material. In the section on flow measurement, most of the design calculation methods in open channel flow are introduced.

Knowledge on design of channel with various shapes is included in the section on design of open channels. Interactive analysis is employed to relieve the intensive computational work for the analytical solution in the design of open channel. Through the graphical interface as shown in Figure 2, "What-if" analysis can be performed by setting various design parameters. Different computational options are provided, namely, rectangular open channel, circular culvert, triangular channel with or without using end depth method, respectively.

Table 1. Results of the feedback questionnaire survey by the learners

Questionnaire item	Average rating#
Users are proficient in using computer.	3.7
Users can actively control the pedagogical process via the tool.	4.0
The package is very helpful in understanding the topic.	4.2
The system is interactive and user-friendly.	4.1
The package is easy to comprehend and greatly accessible.	4.3
The material with multiple formats of presentation is interesting.	4.1
The tool greatly arouses their interest in this subject.	4.0
The presented material is relevant to the domain subject.	4.2

#5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree

5　Evaluation of Package

In order to gauge the effectiveness of the system, 103 learners of varied technical backgrounds and experiences are required to complete a questionnaire with 8 questions that evaluate the presented system after their use. The feedback and written evaluations of the users on the scope and effectiveness of the system comprise several useful points. Table 1 shows the results of the user feedback questionnaire survey on using the system. Owing to the inherent variability in user rankings, only extreme rankings, such as exceeding a rank of '4-Agree', are considered significant. From the results, it is delighted to notice that no aspect of the system receives an unfavourable ranking. The tool is considered to be easy to comprehend, interesting, interactive, and relevant to designers. More importantly, the users find that it is extremely helpful and that the tool greatly arouses their interest in this domain subject. Moreover, during this semester, the student tracking records show that the average number of hits for the site per student is 497 times whilst the average time of hit averages at 2.8 minutes per hit. This proves its capability as well as usefulness in serving the purpose of pedagogical support.

6　Conclusions

A prototype AI-based interactive teaching package for open channel flow on Internet is presented. It is shown that the hybrid knowledge representation approach applying object-oriented programming technique with various latest software is viable for this domain problem. The flexibility and open infrastructure of Internet have been demonstrated to be able to act as a media for developing learning application. Through this package, the domain knowledge on open channel flow can be understood easily. Besides, practical design of open channel flow can be enhanced using the interactive analysis.

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