

Authoring and Presentation Tools for Distance Learning over Interactive TV

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ABSTRACT

We present a complete system for distance learning over interactive TV with novel tools for authoring and presentation of lectures and exams, and evaluation of student and system performance. The main technological contributions of the paper include the development of plug-in software so that PowerPoint can be used to prepare presentations for the set-top-box, a software tool to convert PDF documents containing multiple-choice questions into interactive exams, and a virtual teacher whose facial animation is automatically generated from speech.

Categories and Subject Descriptors

H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems – *animations, evaluation/methodology, video.*

General Terms

Management, Design, Human Factors.

Keywords

Distance education, interactive TV, set-top-box, multimedia presentation.

1. INTRODUCTION

While the World Wide Web (WWW) based distance learning methods seem to be the current dominating trend [1], the utility of television itself as a learning tool is also well recognized [2]. This is especially true for the poorer communities where television has far more penetration than WWW connectivity [3]. Television also provides real-time video transmission like videoconferencing, but since virtually every household has access to a TV set, expensive classroom setups are not necessary.

As stressed in [4], *interactivity* is a core requirement of distance learning systems. Simple interactivity can be provided for digital TV audiences relatively cheaply through a return channel, which

is supported by many set-top-boxes today. Receivers of terrestrial and satellite broadcasts can use phone lines or broadband connections, while cable users can use the cable itself. An introduction to the *interactive television* approach to distance learning (t-learning) and a thorough discussion of its advantages are given in [5], [6] and [7].

The standardization of the Multimedia Home Platform (MHP) [8] has brought about a significant increase in the number of interactive TV applications. The following are some noteworthy examples that include distance learning aspects: [9] describes a case study conducted in Portugal demonstrating the potential of interactive TV as an educational tool; [10] and [11] advise against direct translation of the Internet educational models to the interactive TV, emphasizing low computational demands, extensive use of multimedia contents, and interactivity optimized for the remote control; [11] and [12] describe an XML-based course material preparation system as well as STB JavaBeans software for presentation of the material; [13] presents authoring software for preparing interactive presentations; and [14] describes a cross-platform distance learning system which also incorporates an extensive use of WAP-enabled mobile phones.

In this paper, we present a complete system for distance learning over interactive TV (t-learning) which includes novel tools for authoring and presentation of lectures and exams, as well as evaluation of student and system performance. In particular, we have developed (i) plug-in software so that Microsoft® PowerPoint® can be used to prepare lecture presentations that can be displayed on set-top-boxes (STB), (ii) a software tool to convert Adobe® PDF documents with specific formatting and containing multiple-choice questions into interactive exams that can be executed on STBs, (iii) STB application software utilizing the return path for the students to guide them according to their course performance and (iv) a virtual teacher which is animated automatically from recorded speech of an actual teacher. The system does not currently feature real-time lessons or interactivity with other students (other than performance comparisons). However, there are no technical issues that prevent such future additions.

The overall system architecture and server software setup are presented in Section 2. The tools for preparing lectures, interactive presentations, and exams are described in Section 3. STB software for viewing lesson broadcasts, presentations, and taking exams as well as additional STB software and Web pages to report the evaluation results are described in Section 4. Finally concluding remarks and future work items are given in Section 5.

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2. SYSTEM OVERVIEW

Figure 1 gives an overview of the system as implemented on an MHP Java compliant system. The topmost part of the figure illustrates the authoring components running on a workstation PC. The PowerPoint plug-in is used to author lesson presentations; the exam authoring tool and PDF parser are used to generate exam resources for execution on the STB; and the virtual teacher tool is used to create computer generated instruction videos.

The center portion depicts the broadcasting and return path hardware setup. The database server houses the software for the management of the student records as well as all the lessons and broadcast scheduling information. This scheduling information is connected with a hierarchical course-topic-lesson structure and used to drive the personalized course guides.

The two panes at the bottom represent the software implemented on the STB and the Web interface. The portal provides centralized access to the interactive presentations and examinations as well as the personalized course guide. The portal also allows direct viewing of the broadcast video lessons. The Web site homepage allows enrollment to the system and provides system evaluation feedback to the administrators and teachers, while student performance evaluation reports are also made available here.

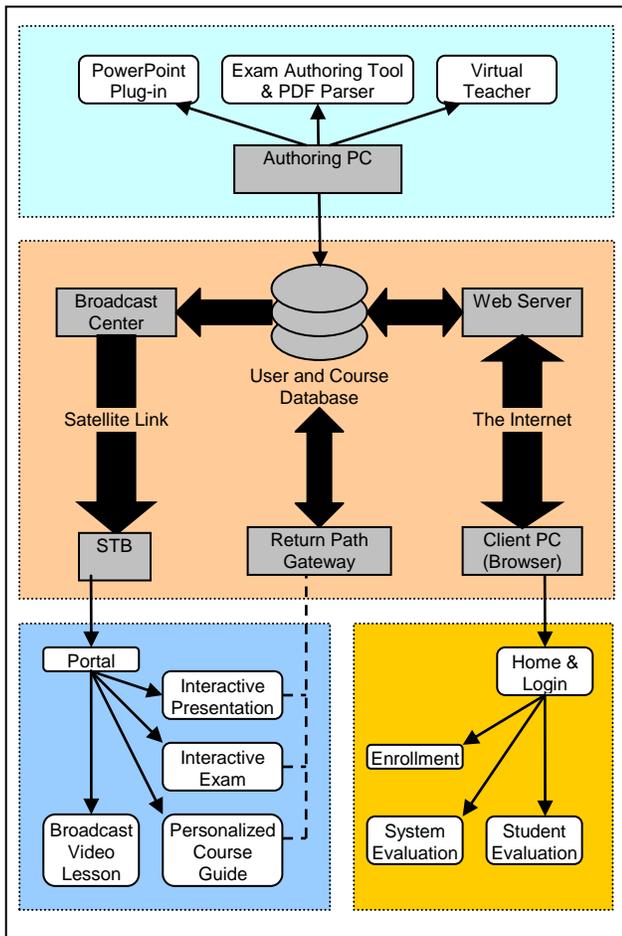


Figure 1. System overview: Authoring tools (top), hardware setup (center), STB client (bottom left), and Web client (bottom right)

3. AUTHORIZING TOOLS

3.1 PowerPoint Plug-In

Our system includes a software component that is installed on a PC workstation as a plug-in to Microsoft PowerPoint. It can be used to export PowerPoint presentations automatically optimized for display by the STBs. This optimization process includes scaling, color reduction, PNG or MPEG compression (as required) and automatic palette generation. The plug-in supports many of the interactive elements of PowerPoint, like animations and (internal) hyperlinks. It also introduces some of its own interactive elements, such as quizzes for evaluating student performance, questions for self assessment, timers for automatic navigation among slides, and embedded TV broadcast displays. It is not required that the presentations be prepared with the plug-in installed, the plug-in will handle old presentations just fine. This means the presentations that teachers have prepared in the past are directly converted for use in our t-learning system. The plug-in produces a directly usable package, along with a GUI and help, that the system administrators can add to the data stream manually or with a scheduler.

3.2 Exam Authoring Tool and PDF Parser

The system features an exam generator consisting of two components: An exam authoring tool component (Figure 2) is implemented to build the exam data for use by the STB client, and a PDF parser is developed for mass input generation for the authoring tool.

The exam authoring tool component is a GUI application that can be used to construct exams interactively by adding exam booklets and questions, as well as metadata like scoring options, timing and navigation restrictions. Since exam questions often make use of visuals, questions that are in image formats are also supported. The application also features previewing capability and automatic checks against questions that are not suitable for TV displays. Aside from these checks, the operators are also provided with a comprehensive guide explaining possible display issues like flickering of one pixel thick horizontal lines, inappropriate color and contrast usage, and fonts known to be difficult to read on TV displays.

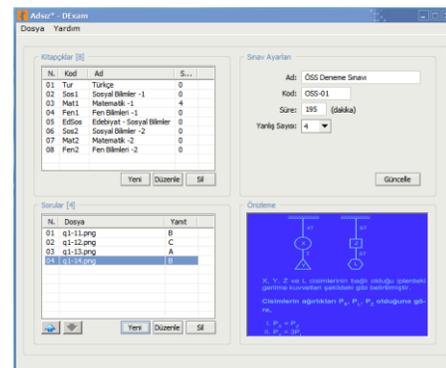


Figure 2. Exam authoring tool for constructing exams

The PDF parser component was developed on the observation that large scale exams with hundreds of questions require impractical authoring labor. The parser component is fed PDF files and automatically produces individual questions, complete with booklet structure that can be used to drive the exam authoring tool

which, in turn, generates the exam package. The current implementation of the parser supports the nationwide university and high school exam styles used in Turkey. A large number of exam PDF's are prepared and published every year in Turkey by several private educational institutions and by the government agencies that administer the various centralized exams.

3.3 Virtual Teacher

In order to make lessons more attractive to younger students, we have developed a 3D virtual teacher tool that can be used to generate instruction videos during lecture preparation (Figure 3). This tool relies on the automatic creation of lip animations given the speech recordings of the lecturer [15] and a 3D rendering engine [16]. It thus becomes possible to add a virtual teacher to PowerPoint presentations accompanied with speech recordings.



Figure 3. Rendering of a virtual teacher on a presentation slide; a cartoonish character is employed here to attract younger students

4. STB AND WWW CLIENTS

4.1 STB Client Software

4.1.1 Portal

The STB components of our system operate on a dedicated video channel with a data stream. Upon first tuning to the channel, the user is greeted with an interactive portal. The portal presents the user with different options depending on the status of the user and the return path. If enrolled, the user can be recognized by the smartcard installed in the STB (the system currently supports only one user per card); but the return path is required for most of the personalized data. This is necessary to make the system more scalable, since the available bandwidth in the data stream is fixed. If the user is not enrolled, the portal contains only generic options.

Through the portal, the user can reach the interactive presentations that may be on-the-air at the time. If an exam is available, the portal also provides the access to it. The video lessons currently being broadcast can also be watched through a dedicated display mode in the portal. Provided the return path is available, the registered users can also reach the course guide personalized for their own records.

4.1.2 Interactive Presentation

The interactive presentations are accessible to the user through the portal. By triggering a particular option, the user can view the available material and navigate as desired. Since presentations are derived originally from PowerPoint documents, they are

structured similarly as slide sequences, where each slide may contain a number of visual elements. The presentations can be navigated linearly or conditionally depending on their content, and can also be viewed simultaneously with the video lessons being broadcast.

Presentations feature additional embedded software that tracks the user's behavior interacting with the presentation. Some statistics are collected automatically to deduce the user's attendance and interest in the related course and the presentation in particular.

More direct feedback can be given to the student by embedding short questions in the presentations. This can be done through the plug-in while the presentation is being designed in PowerPoint. The questions can provide immediate feedback to the student about how much he/she has learned. Further evaluation is also possible through quizzes. A quiz consisting of several questions can be added to the presentations to track the learner's performance. Unlike short questions, the quizzes send their results through the return path for future guidance.

4.1.3 Interactive Exam

Special STB software has been developed to support large scale timed examinations as well. Depending on the scheduling decisions, it is possible to make specific exams available at the portal options. These exams also employ the return path for guidance and comparisons.

The student navigates through the exam according to the timing and navigation restrictions and is scored according to the exam's scoring scheme when the time is up. Statistics of the exam as well as the correct answers to the questions are made available to the student while the results are also sent to the servers through the return path.

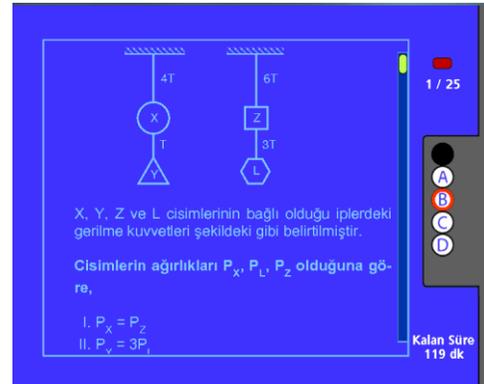


Figure 4. An exam in session: The question window, question number and number of questions in booklet, available choices, and the remaining time

4.1.4 Broadcast Video Lesson

Lessons can be broadcast in typical classroom format as well. There are no restrictions on how the video content is prepared. The current implementation is based on broadcasting of prerecorded videos, however live programs are also possible. The lessons are not served on demand; instead, they are rotated in a schedule. The broadcasting equipment that our system has been deployed on already provided scheduling tools to manage broadcast programs, however, these tools could not be customized enough for a specific service such as ours. Hence, the database

was augmented with the necessary scheduling data to support the lesson programs.

4.1.5 Personalized Course Guide

The user can also reach from the portal the program guide for the lessons of the week. The program guide is personalized to the user and shows only the lessons of the courses the user is enrolled in, stressing the ones the user has missed or has demonstrated insufficient performance for. This information is derived from the user's past experience with the lessons, as well as his/her performance with the quiz and exam questions on the related topic. The guide also summarizes of the user's performance statistics in the courses he/she has enrolled in. A comparison to the other enrolled students is also provided for the student.

4.2 WWW Client Software

4.2.1 Enrolling to the System

In order to receive personalized services from the system, a prospective student must first enroll to the system. This can be done via the WWW site, the STB portal or even through SMS services. The enrolling process for a commercial implementation would be somewhat more complicated, as it would require accounting and billing procedures as well.

4.2.2 System and Student Evaluation

An evaluation of lessons, teachers, presentations, software and overall quality of the service is collected through online surveys on the STB. This information is made available to the respective parties through the Web. For instance, evaluations of the lessons and the teachers are made available to the teachers themselves while software performance feedback is forwarded to system administrators. The performances of the students in the courses they are enrolled in are also provided on their own pages on the Web interface. The information on these pages is virtually identical to that available on the personalized course guides.

5. CONCLUSION AND FUTURE WORK

The interactive TV system presented in this paper constitutes a complete distance learning solution that can be used to author and present interactive presentation content, hold exams, provide performance evaluation and guidance services on compatible set-top-boxes. The highlights include the practical solutions brought to the problems of content authoring for both presentations and evaluation tools (quizzes and exams).

While most contemporary solutions for this problem make use of the World Wide Web, using broadcast TV brings several advantages for the learners. Unlike computers, TV sets are easy to use and are practically available in every household and moreover, support video transmission without the specialized expensive hardware requirements of videoconferencing.

As future directions, we consider supporting additional features of PowerPoint, question types other than multiple-choice for exams, and supporting more flexible PDF exam formats. In addition, tests with real learners are also planned for an evaluation of the system.

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