Developing Innovative Multimedia Instructional Modules for Control Flow Theory

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Abstract

In this paper the development of prototype instructional modules for teaching Control Flow Theory is discussed. The modules are intended for use by practicing engineers as a self-paced, asynchronous, personalized learning material, either on-line or off-line. First, the motivation of this work and the selection of software used in the modules are presented, the architecture of the module is then described, the lessons learned in the development process are further discussed and future improvements of the modules are proposed.

Motivation

In April 2002, NASA initiated and funded a seven university consortium led by Old Dominion University's Center for Advanced Engineering Environments to develop the Hierarchical Learning Network as one of the initiatives searching for remedies for the projected loss of engineering expertise due to aging of present workforce and a continuous decrease in the number of graduating engineers. This learning and research network will provide a prototype for linking diverse, geographically dispersed teams and facilities from academe, government and industry, combining their expertise to create a new generation of skilled scientists and engineers who can work across traditional disciplines and perform in rapidly changing environments [Goldin, 1].

In particular, the consortium proposed to capitalize on the faculty expertise and research facilities at Old Dominion University, University of Florida, University of Illinois at Urbana-Champaign, George Mason University, MIT Media Lab, Cornell University, and Syracuse University, to provide world-class engineering education and aerospace workforce training. The consortium will develop new multi-university group-teaching courses and advanced learning modules with the objective to ensure the rapid transfer of the research results to industry [Noor,2].

A key concept to the Consortium efforts is the modular approach to producing learning materials. This approach supports the use of the same learning material for both the engineering student, the engineer in training and the seasoned practitioner, the difference being in the quantity of background information and the level of detail needed

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by each individual. The approach is similar to the one used in Lego constructions, where the same Lego (read here learning object) can be used as base, as middle or as top part for a construction. The analogy, however, is valid only up to a point: aside from the mere software compatibility of the learning objects (addressed by designing ADL/SCORM- compatible objects) is their logical, knowledge progression, compatibility.

This paper presents the authors experiences in creating prototype instructional modules for Control Flow Theory. While the technical content of our application (the learning material per se) and the module organization is specific to our application, the software selection process, as well as what we learnt during the first year of development, are of interest to a larger community of educators interested in on-line and long-distance education.

Selection of Software

The technical content of each module was organized in concept maps, using specifically the software produced by the Institute for Human and Machine Cognition, CmapTools v2.9.1 (for details on this free software see http://cmap.ihmc.us/). A concept map is a hierarchically organized, two-dimensional representation of a set of concepts and the labeled relationships among them with the most super-ordinate concept being placed at the top of hierarchy. Concept maps can also contain cross-links, which represent relationships among sub-branches in the hierarchy. As such, using concept maps to organize content offers a more intuitive navigation method than a classical table of contents. An example of Concept Map is presented in Fig. 1.

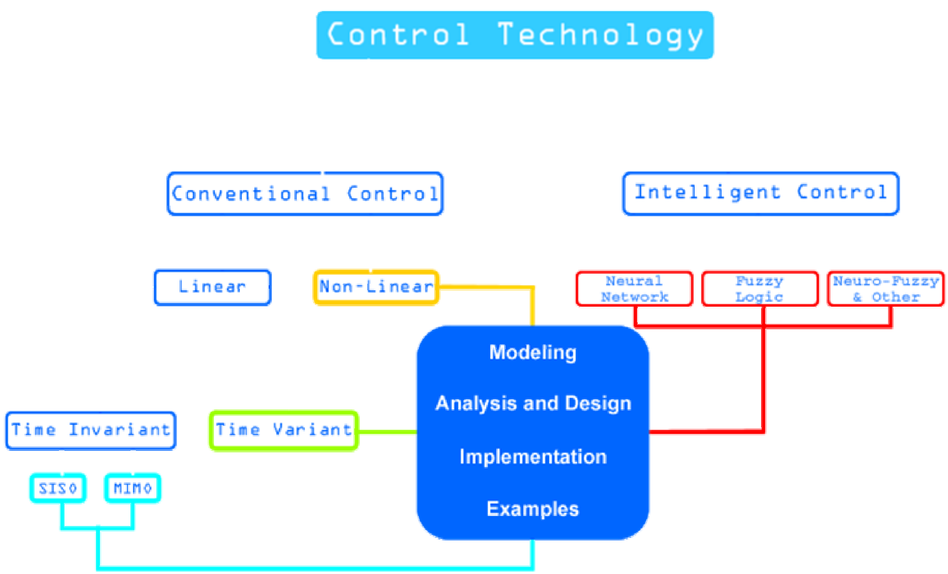

Figure 1: Example of Concept Map-Control Technology

Most of the animation used in our modules is produced by the fourth author in Macromedia's Flash, supplemented by scientific simulations realized in Mathcad. Flash was chosen for its small file size and its portability of the final product across browsers and operating systems. For scientific simulation, Mathcad was preferred to the competing software Matlab or Mathematica, mostly because of the previous experience with the software of the simulations author, the second author of this paper

Each user's progress in covering the material is tracked using Macromedia's Authorware capabilities. This software can be used to create personal accounts, to allow timed or conditioned release of specific material, track how much material was covered, and to stop and restarting the presentation from the previous session exit point.

The same user tracking capabilities were offered by both Authorware and a Learning Management System (LMS) such as WebCT or Blackboard. The difference however, was one of scale and portability. The above-mentioned LMSs are tailored for use in higher education institutions and as such are cost-effective when used by a large number of people at the same institution. As the audience of our learning modules was geographically dispersed and of variable number at any given time and any given institution, an LMS was not the best possible solution.

In contrast, Authorware applications can be run under most modern Windows and Macintosh platforms, and the Authorware player is free to download and plays files produced with older version of the software. In this way, the cost-burden is transferred from the educational material user to its producer. Moreover, Authorware movies can be published in different formats, to be played from a CD or from the Web/ an internal network, and they can be further integrated in a LMS. A screen shot of the starting point of our module is presented in Fig. 2. However, working with Authorware had its own challenges, and we further discuss them in the Lessons Learnt section.

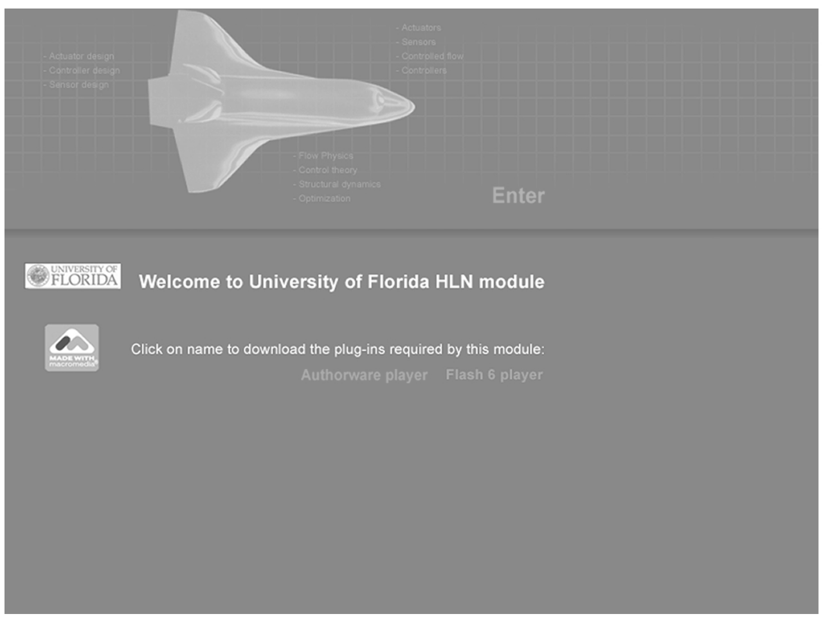

Figure 2 : Entry screen to the produced Authorware module

Lessons Learnt

One of the reasons for using Authorware in managing the teaching material (as opposed to using a straight-forward Flash application) was to allow tracking of the users' navigation/learning path. However, we found that even when using Authorware for content management it is still impossible to return from outside a Flash movie to a fixed point in a Flash presentation, so it is practically impossible to remember exactly how much of a movie someone has seen. Therefore it is important to keep each Flash object to a minimum of length, so inside object navigation is reduced to a minimum. This has the disadvantage of increasing the number of objects to be managed by Authorware.

The delicate balance of large versus small files is also disturbed by the interference of 2 audio files when navigating to a new file/new scene in the same page of a Flash document. Figure 3 presents such an example, where having the mouse rolling over any of the numerical keys started an audio description of the corresponding menu, while pressing the key moved to the respective scene in the movie and a new audio effect.

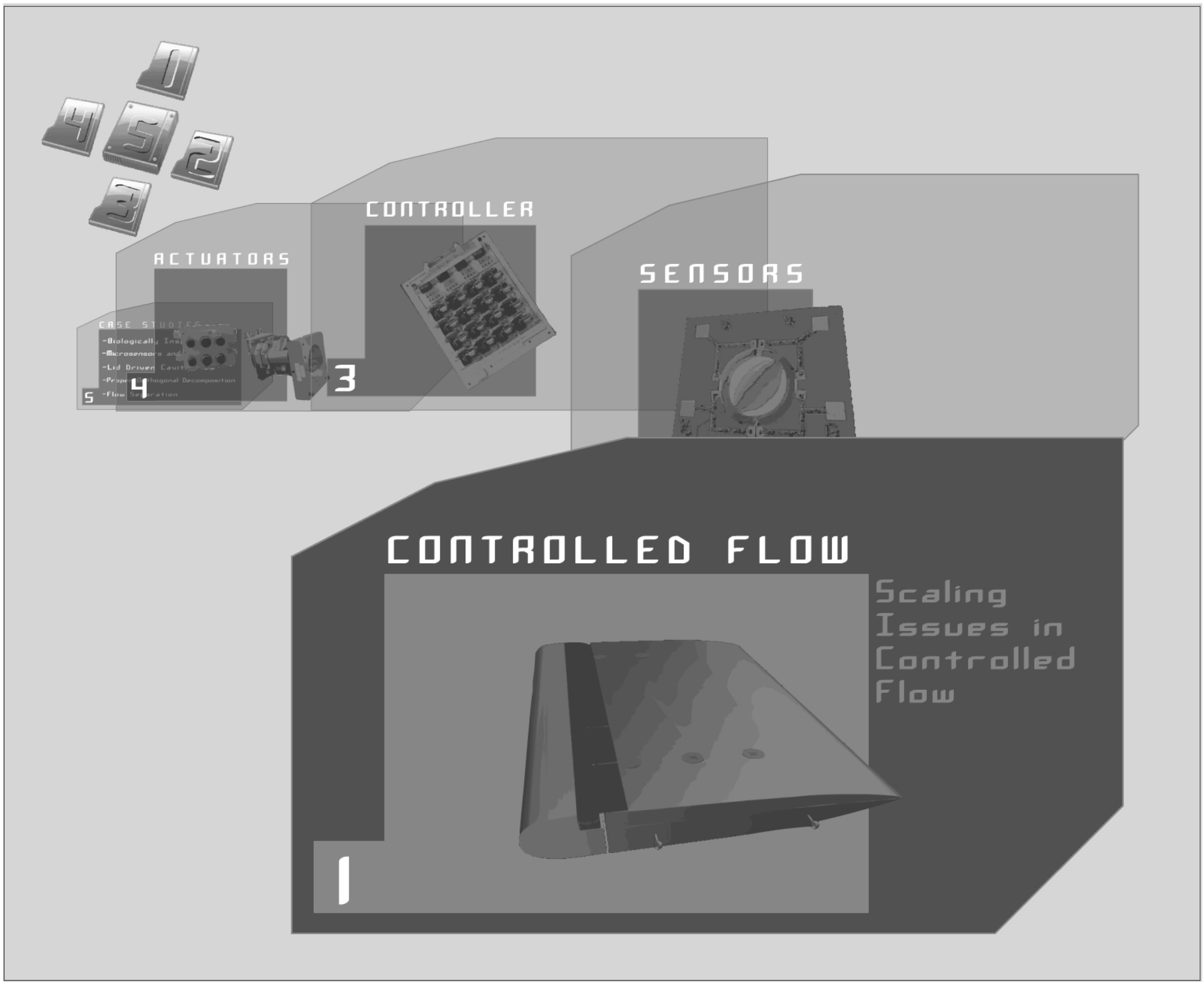

Figure 3: Example of Navigation menu

We had been able to coordinate navigation and sound playing while navigating in the same document, but not between documents. Another idea would be to keep the audio and video part of the presentation coordinated, but in different files. We have not implemented this idea but we will appreciate comments and suggestions on the subject from readers in the known.

A different difficulty was the impossibility of editing/printing materials directly from Authorware. One possible solution is to provide a pdf version of the text and illustrations for each section in a module. Alternately, one can create a 'Notes' feature, such that the student can annotate the followed modules.

While evaluating our/others product on-line, the speed of the connection was a factor. We had pages 'frozen' for 5-20 minutes while loading a big presentation. We dealt with this challenge by installing pre-loaders and 'please, wait' menus wherever appropriate. A more radical approach is to break any big presentation in smaller subsections, with the previously mentioned advantage in tracking user progress, and the disadvantage in increasing the number of objects that need to be managed.

While the previous challenges were technical, the following ones were related to project management and human communication. First one was to coordinate the graphic scheme between different designers/ different parts of the module. One solution is to have, if possible, one 'permanent, full time' employee in charge with the graphic design part. If not, get together at least once a week to discuss progress and exchange background files and templates. The final result it will be worth the effort.

A second challenge is the miscommunication between the graphic designer and the content author. The solution is to have someone in charge with explaining the engineering shortcuts and conventions to the graphic designer. This is extremely important when the presentation designer has a Fine Arts and not a technical background.

A continuous challenge was to find technical support people with the needed software knowledge. For example, when we started our project was not possible to find in our institution a person knowing Authorware and willing to work for us. The solution is to build-in paid time for learning software, and to be willing to use a combination of outside and in-house technical support (and pay for it).

Another problem was the retention of technical support people. Our suggested solution is to make known, during the interviewing process, that commitments longer than one semester are expected and paid (for example hourly wage increase of $1-2/hour after each semester of satisfactory performance). That would helpfully retain employees and maintain the continuity of the technical support. The project manager had also to stress the good work practice of thoroughly documenting the thinking used in programming and the organization of computer files.

Future Improvements

A first needed improvement is to devise and implement an assessment plan of the learning efficacy of the modules. Indeed, in its present form, the module content is scientifically sound and up-to-date, while the module presentation is graphically pleasant and bug-free. However, there was no formal assessment testing conduced on the module efficacy or on the self-sufficiency of the presentation.

A second improvement is to add quizzes and pre/post-tests designed to add the content navigation and check the users' understanding of the studied material. Indeed, because the hierarchical learning networks are designed to be used with limited content support, it is important to have built-in self-tests and checks for understanding. If possible we will design for each module a 'questions from the public' database as well as an on-line forum of present and past students. We also need to add 'open question' sections, that is sections introducing the still unsolved challenges connected to the presented material.

References

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