Framework for Deve l opment of Course Material for Teaching Computer Graphics

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Abstract

In this paper we define the framework for developing course material to teach Computer Graphics courses. The paper will mainly discuss what support material is desired for effective teaching/learning the subject rather than implementation of a teaching tool. It lays emphasis on three important components of the courseware, mainly the design of course content, an experimenter's workbench and an assessment tool. The framework envisages the need for an integrated approach to courseware development for teaching / learning Computer Graphics. This approach would clearly separate the role of courseware developer from that of the delivery person (traditional teacher). The main theme of the paper is to develop learner-centric course content that will depend less on the teacher and more on the learner. Such a courseware would support three independent perspectives. Firstly, the developer's or author's perspective, which would view the course content as data or media objects that could be easily shared, maintained and reused in other courses. Secondly, the learner's perspective, which would accord the learner a platform-independent experimental workbench to learn by hands-on experience. Finally, the administrator's perspective which would collect feedback on each learner's progress and performance.

Keywords: *Web-based education, Instructional design, Computer graphics courseware.*

1. Introduction

Computer Graphics as a discipline has matured over the last three decades. Today many universities teach more than one course on Computer Graphics at different levels to students with background in science, engineering and fine arts. Often the objective and the pre-requisites for each of these courses are different although there is fair amount of overlap in its content. It is visualized that good course material for teaching these courses would contain high volume of multimedia content such as visuals, animations, audio, video and simulations besides the text. Therefore to design the course material for computer graphics course has always been a challenge to both the educationist and the technologist. Kayssi et al. have discussed similar issues in a recent publication on the application of web-based tutoring as applied to computer networks courses [1].

There is no doubt that for an effective delivery of the course, a lot of efforts go into the preparation of course material to be used in the class room by the instructor. The additional support material such as student notes, laboratory assignments, reading material and self-tests, further enhances the quality of instructions. For a highly developed networked infrastructure, which is available today, it is unfortunate that each instructor has to develop this material from scratch. It is an accepted fact that good experienced teachers are difficult to come by and this approach will have limited applicability and will not scale-up.

One important aspect of any course on Computer Graphics is experimentation. Typically the instructor gives a series of assignments and students solve these assignments and learn the concept by actual implementation. The common difficulty faced by the student during implementation is that they have to build the application from scratch. This can be very time consuming and frustrating exercise.

It is also noticed that students who like programming otherwise are some times intimidated with matrix notation, vector algebra, 3D geometry and Calculus. Often these subjects are taught in the first few years of college education and by the time student opts for computer graphics course, these concepts are forgotten. As a result, students associate computer graphics to mathematics and develop an unnecessary fear for the subject. This makes it

mandatory for the instructor to review some of these mathematical preliminaries in the class, before proceeding to teach Computer Graphics concepts and algorithms. Further, the approaches taken to teach a fundamental course and an advance course may be different. For example, in a fundamental course on Computer Graphics, more emphasis may be laid on data structures and algorithms and a student may be expected to implement these concepts from ground-zero. On the other hand, for an advance course, the emphasis may be more towards making use of canned code in order to build reasonably complex visualization programs.

2. Graphics Courseware Components

In order to create resource material to be shared among a group of instructors and the students, adequate measures should be taken at the design and development stage. It is a matter of fact that the teachers often prefer to improve upon their own course material after each delivery of the course. Therefore, it is important that such a course material is highly modular in content, reusable, easy to maintain, store and distribute. Further it should provide the scope for the instructor to customize it to keep the learner motivated.

For quite some time now, a need has been felt by the Computer Graphics community to define a Graphics Workbench, a tool to carry out experimentation in visualization. Such a workbench would allow the students to experiment with Computer Graphics concepts without having to write a lot of additional code. It would require to have easy to learn easy to use API that would allow anyone to implement a graphics module that can be designed at a higher level, independent of any specific platform and tested on a modest system with requirements commonly available at work and home.

Assessment is an essential part of any training. An assessment tool should not only collect the statistics about usage, evaluation and progress of a particular learner but also provide assistance to the author to prepare questions and answers for an on-line test.

The framework suggests that all three components are essential to give an integrated view of the courseware to the learner.

3. Instructional Design Strategy

The development of course content is an extremely labor intensive and time-consuming process. Therefore it is important that proper care is taken at the instructional design stage so that the course content can be easily modified and maintained. One method to do this is to design course material in a modular way with a hierarchical structure of concepts and separation of course structure from individual concepts [2]. Each concept will be an independent entity in itself with well-defined objectives, pre-requisites and evaluation criteria. Course material organized in this fashion can be modified easily without much effort. There can be more than one structure to organize the courseware. This will allow two learners with different learning profiles and taking the same course, to be presented with different learning material. Further, it is observed that if the students do pre-work before arriving at the training session, the learning process then becomes proactive rather than reactive resulting in better comprehension and retention.

Important processes in courseware design would involve the definition of a set of concepts. Each concept would define the following:

- Concept objectives
- Any pre-requisites
- Relation to other concepts
- Questions & answers
- Testing material
- Trainer's guide
- Student's material (pre-work)
- Classroom slides
- Lab Assignments & Solution
- Reading material

The courseware design team would involve a set of subject experts, an instructional designer, a couple of programmers, and graphic artists. It is very important to realize that the development of good instructional material lies much beyond the expertise of subject experts. It definitely involves a team effort and cross-disciplinary approach. The required skills could be best compared to that of web page design if not to making a film. Since several subject experts could be involved, a template has to be prepared in order to provide a uniform structure for developing course content. Such a template can also help in identifying the properties of the content, which can be used later for managing the content. [3]

4. Architecture

The suggested architecture for development of courseware is based on client/server model and would use a relational database as a central repository for storing different media objects. The vast popularity of the Internet and the World Wide Web has made the Web browser as the most consistent cross-platform solution for browsing multimedia data. This would also provide a common user interface to developers, learners and administrators, a platform independent client from any location on the Internet/Intranet. The interactivity can be achieved through cross-platform languages such as Java. For example, to communicate the concept of interactive curve design, a Java applet can be written to input the points interactively and drawing a Bézier curve and then displacing one of the points and redrawing the curve. Any amount of hand waving in a classroom cannot communicate this concept effectively but a simple demo will do the trick.

5. Graphics Workbench

The experimentation Graphics Workbench (GW) will basically have a visual experimentation environment that can allow a learner to easily set up and test customized sequences of a graphics pipeline. It can not only help the learner to create and edit complex geometrical models but also test ones own module by plugging it along with other modules pipelined in a complex data flow graph called module network. The workbench will perform automatic module scheduling in a module network. This will allow the learner to modify parameter for each module in the network, automatically re-scheduling all modules affected by a parameter value change. It will support rich set of graphic file formats and have large set of graphics modules arranged in a hierarchical library for the fast and task oriented retrieval.

Typically a computer graphics application can be modeled as a set of cooperating processes of three types as shown in Figure 1.

- Input processes, responsible inputting the geometric model into the system
- Computational processes responsible for performing one or more graphic operations on the geometric model
- Presentation processes and display processes, responsible for presenting and storing the output result.

When designing a stand-alone application, one typically would describe the application in a top-down fashion. The description would begin with the overall structure of the application and would end with a detailed description of each process including its inputs, outputs and function. This can help the learner to rapidly prototype an application using the GW.

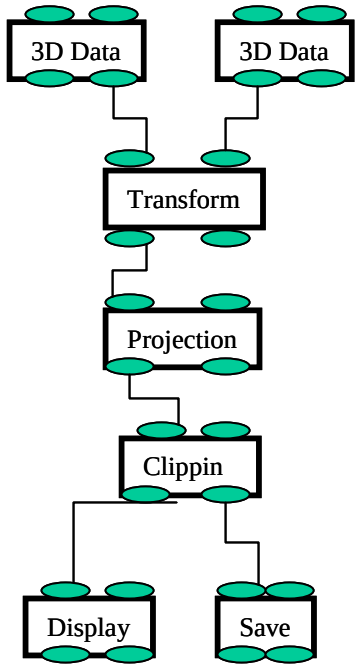

Figure 1. Data flow graph showing a network.

6. Evaluation Tool

This tool would help the teacher and the learner to track the progress and performance of an individual. In addition, it would keep a statistics about the difficulty of the question by its usage. It will consist of set of forms and wizards that would allow the author to create variety of objective questions of the type:

- True and false questions
- Multiple choice questions
- Match the columns
- Questions using interactive simulations

Each question and its answer are stored in the database to form a question bank. Each time a student wants to take the test, it would select the question randomly form the question bank, set the number of questions and the time. The wrong answer to any of the question would link back to concepts in the courseware. It may also include

hints, instructions and advise to a particular question using different media types such as text, audio or a video.

7. Conclusions

The concept paper outlines the need, objectives and suggests an integrated approach to courseware development for teaching / learning computer graphics. It envisages that such a courseware would be able to support three independent perspectives each for the author, learner and the administrator so that effective learning can be monitored closely.

References

[1] Kayssi A., El-Haji A., El Assir, M., Sayyid, R., Web-based tutoring and testing in a computer networks course, Computer Applications in Engineering Education Vol. 7 No.1, 1999

[2] Teixeira J. C., Paris C., Brisson Lopes J.M., Paiva, A.M., Authoring Courseware for Distributed Environments Proceedings ICVC'99 held in Goa, India, February 1999

[3] Connolly C. Developing Learner Centric Content, White paper Empower Corporation, 1998 (http://www.empower-co.com)