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E-learning Software for Mathematical Concepts and Algorithms of Computer Graphics

¹Rajiv Dharaskar, ¹V. Bajpayee, ¹N. Chube and ²Vilas Thakre

¹Department of Computer Technology MP Institute of Engineering and Technology,
Gondia, MS, India 441614

²Department Computer Science, Amravati University, Amravati, MS, India 444602

Abstract: The Computer Graphics is one of the core and difficult subjects of Computer discipline. It involves mathematics (coordinate geometry), hardware and complicated mathematical algorithms. To teach the working of the complicated algorithms using blackboard is a difficult. On the top of that, three-dimensional concepts cannot be explained with the help of traditional black board teaching techniques. To develop the e-learning product for such subject is a difficult task. Lot of research is going on to develop efficient system to teach this subject with the help of latest technologies. This study describes a new technique for developing e-learning software for such a difficult subject. The main objectives of this work are to provide most effective and time efficient e-learning solution to teach Computer Graphics to the students of computer discipline with the help of innovative e-learning methods, latest tools and technologies.

Key words: Computer graphics, E-learning, learning objects, LMS

INTRODUCTION

The Computer graphics is the core subject of computer stream. It is one of the difficult subjects for teaching as well as learning. To understand this subject the knowledge of computer programming language (C, C++, Java, DirectX, OpenGL, 3D Java API etc.), data structure, advanced coordinate geometry and computer hardware is needed. In many universities the students can opt the computer graphics subject only after successful completion of course module on mathematics. On the top of that the data structure itself is the difficult core subject. That is not all; the computer graphics is totally dependent on computer hardware. In addition to this power of 3-D visualization plays important role. All these are interlinked. To teach one topic many times the knowledge of other topics are required. For example, the knowledge of display adapter cards, VDU memory, Random Access Memory, working of microprocessor, DAC Registers etc. is needed to teach the preliminary concepts like pixel, Frame Buffer Array, bit planes, Text/Graphics modes, Color palettes, Interlacing and even the simplest DDA and Bresenham line drawing algorithms. The advanced topics like Transformations, Polygon filling, Hidden line removal cannot be taught properly without knowing the above mentioned preliminary concepts. Thus to develop the e-learning software for this subject is always a challenging task^[1,2].

This study describes a very effective technique for developing e-learning software for such a difficult subject. To achieve this goal, the entire syllabus of this subject has been divided into four parts namely algorithms, 2d/3d Graphics (Transformations), 3d Graphics, Working of Computer Graphics System. For each task different e-learning techniques have been developed^[3,5]. The main objectives of this study are to provide most effective and time efficient e-learning solution to teach Computer Graphics to the students of computer discipline with the help of innovative e-learning methods, latest tools and technologies.

E-PEDAGOGY AND MULTIMEDIA DESIGN ASPECTS

While designing the e-learning software various e-pedagogy aspects have been considered like^[6-9].

- Working of human brain: Long Term, Short Term and Sensory Memory
- Memory Retention Process of Human Brain
- Learning Theories like Multiple Intelligence, Cue Summation Principal, Cone of Learning, Impact of Emotion on memory, Minimum Cognitive load, Multimedia and Long Term Memory, Involvement of Multiple Senses of Human brain, Principal of Correlation and Memory retention etc.

MULTIMEDIA CONSIDERATIONS

While developing the e-learning multimedia based software the audio-visual quality is a vital issue. For better multimedia quality the following factors have been considered^[10].

- Recording Environment
- Hardware Selection: Microphone, Cable, Connectors, Sound Cards, Primary Memory, Computer System, Graphics Cards etc
- Software Considerations: Audio Codecs, Audio Editing Softwares, Audio Codec Converters, Audio File formats, Monitor Resolution and Color depth, Video Codecs, Audio and Video Synchronization, Raster and Vector Graphics, Video File Formats, Windows Environment settings

TECHNIQUES FOR COMPUTER GRAPHICS ALGORITHMS

First phase: The algorithms consume more than 50% teaching time for this subject. It is difficult to visualize the working of these algorithms with the help of blackboard. To understand the logic of algorithms, the student must know the effect of algorithm on drawing object in a step-by-step manner. The pseudo simulation of the algorithm is the better technique teaching these algorithms^[11]. In the first phase the pseudo simulation technique has been developed with the help of MS PowerPoint as shown in Fig. 1 and 2. This simulation shows every step of the algorithm and its effect diagrammatically. Generally 10 h are required to teach 15 important algorithms of this subject. Using this technique just one and half hour is more than sufficient. It shows the efficiency of this method^[12].

Second phase: The MS PowerPoint has been preferred in the first phase because after feedback of students the necessary modification can be done instantly. In addition to this, these PowerPoint slides can be utilized directly to develop web based e-learning system through Reusable Learning Objects (RLO) with the help of SCORM (Shareable Content Object Reference Model) specifications and Open Source Learning Management System like Moodle^[13,14]. The design part of this phase is completed and implementation is under process^[15].

The best free softwares for developing the SCORM compatible RLO has been provided by RELOAD Systems namely RELOAD Content Package and Metadata Editor, Learning Design Editor and Players. RELOAD is part of the X4L (Exchange for Learning) program funded by

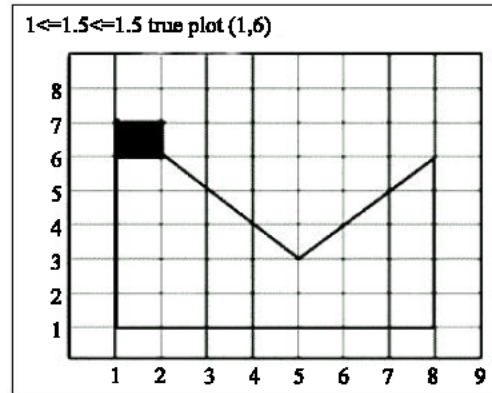


Fig. 1: Simulation first-screen

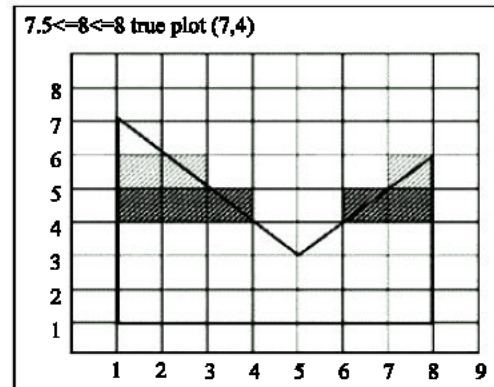


Fig. 2: Simulation fourth-screen

the Joint Information Systems Committee (JISC)^[16]. The JISC promotes the innovative application and use of information systems and information technology in further and higher education across the UK. These software have been used to developed XML based, SCORM compatible RLO.

Third phase: According IDC (International Data Corporations), in 2003 the number of mobile phones exceeds the number of PC in the world. On the top of this, the internet access through mobile/handheld devices is far greater than desktop computers. Thus the m-learning (mobile learning) will be next generation of e-learning. Many mobile/handheld devices can be used for m-learning like mobile phones, extensible mobile phones, smart phones, laptops, notebooks, tablet PCS, PDAs and Pocket PCS etc. The m-learning needs totally different programming techniques. The planning of m-learning has been started for this phase using Midlets with the help of J2ME (Java 2 for Micro Edition), Java Toolkit as well as through Macromedia Flash Lite 1.1 for mobile devices. It will take one more year to complete this phase.

TWO-DIMENSIONAL GRAPHICS

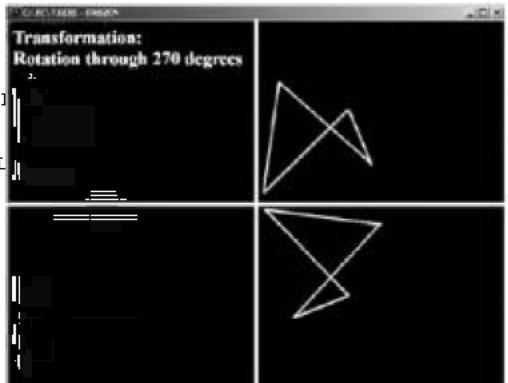


Fig. 3: Rotation by 270-degree

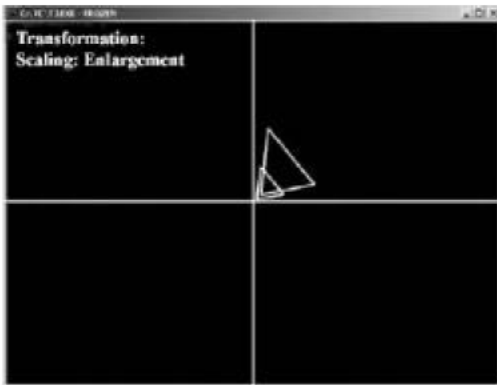


Fig. 4: Enlargement

First phase: According to Gardner's theory there are 7 types of learners and one third of students are visual learners. This means 2/3 are not visual learners. To teach two/three-dimensional graphics to these categories of students is quite difficult using traditional methods like blackboard^[16]. For 2-D/3D transformations, a new technique has been developed using C language. This software demonstrates every type of two-dimensional transformations for user-selected shape. To draw this shape the user provides the coordinates of vertices. The software shows original and transformed shape as shown in Fig. 3 and 4. To teach entire two-dimensional transformations a minimum of 12 h are required. Using this technique just 1 h is sufficient. It's an open source code, thus students can learn more by studying the C coding of this program^[17-19].

Second and third phase: The software will be converted into Java Applet for a web-based e-learning solution. For developing more effective software, Flash and Java combination will be used^[20-22]. Again for M-Learning the design process for the third phase has been started.

THREE DIMENSIONAL GRAPHICS

The three-dimensional graphics visualization is the most challenging task for the students. To demonstrate this concept presently Rhino 2.0 software has been used (Fig. 5). This software supports very useful command line

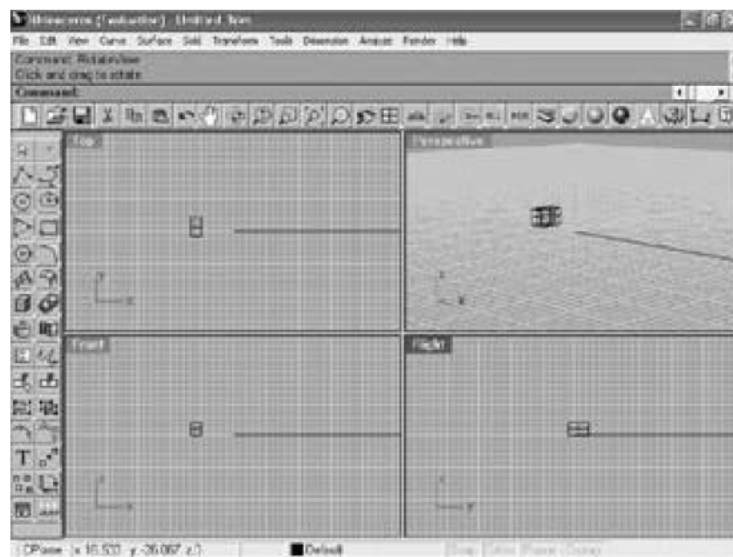


Fig. 5: Rhino 2.0 screen shot

user interface. After drawing the object, it can be viewed by any angle. Even it supports three-dimensional views as well rotation facility. On the same line the development of Java Applet has been started. It involves very complicated mathematics and will require 6 months to develop^[23-25].

WORKING OF COMPUTER GRAPHICS SYSTEM

The working of the computer graphics system has been simulated with the help of Flash and Java. As compare to above techniques it is simple but time consuming job.

RESULTS

The e-learning software has been tested on 4 batches of 10 students each. The experiment has been repeated for 2 consecutive years on different batches. Table 1 shows the summarized result.

Table 1: Summarized results

Teaching method	1	2	3	4
Class-room teaching using Blackboard	0%	60 h		
Using e-learning softwares	56 to 60%	17 to 18 h	Overall 24% improvement	4 Times more syllabus can be teach for topics which have taught fully through e-learning softwares

1 = Percentage of class-room teaching replaced, 2 = Total time required to teach the entire syllabus, 3 = Results of examination shows improvement of memory retention, 4 = Teaching speed enhancement

CONCLUSIONS

The innovative e-learning techniques have drastically reduced the teaching time of computer graphics. The experience shows that these e-learning techniques make the teaching-learning process 4 times faster than classroom teaching. This new method is more effective than traditional methods of teaching. It also helps a lot for the memory retention process of students for this subject. The computer graphics is very complicated subject and thus only 60% classroom teaching can be replaced using these techniques.

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