بنا "أداة معملية افتراضية" لدعم التعلّم الإلكتروني

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ملخص البحث:

مع تزايد عدد الطلاب الجامعيين ب معدلات مرتفعة تجنباً لعوامل الداخلة المتباينة داخل المملكة العربية السعودية والخارجية، ومع قلة الموارد المادية المتاحة لتقديم المواد التدريسية، أصبح بنا "أداة معملية افتراضية" مبتكرة للتدريب مهارة اللغة الفردية ضرورة ملحمة، وذلك لسد هذه الفجوة الهامة، وذلك بحاجة العلمية التفاعلية للطلاب الجامعيين. هذه الأسباب يعرض هذا البحث طريقة تصميم وبناء "أداة معملية افتراضية" Virtual Reality Lab Tool، يمكن استخدامها في تدريس علم "الจรافيك والأشكال الثلاثية الأبعاد" بلغة الواقع الافتراضي VRML للطلاب الجامعيين. وهذه الطريقة تدعم التعلم الإلكتروني الموانئ عبر الإنترنت. و يتحقق بذلك التوجه نحو تجنيج إنشاء بيئة تعليمية جامعية واعدة ضمن مقومات الجامعة الافتراضية، وفي دعم واستحداث أساليب تعليمية ذكية تعمل كأحد ركائز مقومات لنجاح البيئة الجامعية الذكية.
يعرض البحث بالتفصيل المميزات العديدة لاستخدام تقنيات الواقع الافتراضي في البيئة التعليمية الجامعية، والذي يشمل على استخدام الوسائط المتعددة نصية ومرئية وصوتية. ويناقش البحث طريقة تصميم وبناء وتقييم مختلف مشاهد العلمي للمنهج التعليمي لدعم التعليم الإلكتروني الواسع النطاق عبر الإنترنت. ثم يعرض البحث مكونات بناء الأداة العملية الافتراضية بالتفصيل، والتي تم بناءها باستخدام لغة تميزة الواقع الافتراضي VRML. وقد استخدمت هذه الأداة العملية الافتراضية الجديدة في تدريس مقرر علم الجرافيك المتقدم ثلاثي الأبعاد، لطلاب الدراسات العليا بكلية الحاسبات وتقنية المعلومات بجدة، جامعة الملك عبد العزيز. ويعرض البحث بعض نتائج التجربة العملية الناجحة باستخدام هذه الطريقة المقترحة، وذلك لإبراز مدى نجاحها في رفع مستوى التحصيل العلمي لدى الطلاب الجامعيين.
Adaptive E-Learning: “Web Based VR Lab Tool”

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Abstract

Nowadays, Virtual reality (VR) based laboratory tools are gaining more popularity in many different science and industrial training fields and applications, among these are e-learning VR environments. These because of VR environments and technologies are available; relatively; in low cost. This helps and encourages VR lab designers to implement such Lab facilities and tools effectively and economically, in schools and universities to fill in the gaps exist due to the lack of equipments that cannot be offered easily due to their expensive cost. In this paper, a design and implementation for a virtual reality e-learning lab tool that can be used for teaching Virtual Reality Modeling Language (VRML) graphics and animation is presented. This VR Lab tool is implemented using the
commercial software available in the market; among these are e-Book multimedia authoring tools, VRML-Pad text editor, Cortona3D graphics viewer, and HTML web page design language. The proposed VR-Lab tool is designed and implemented to work as an adaptive e-learning web based tool, since it contains an adaptive VRML e-contents that are allocated according to each individual students learning styles. This VR-Lab tool is used effectively for teaching postgraduate students in the advanced course of computer graphics at the faculty of computing and information technology, King Abdul-Aziz University in Jeddah, Saudi Arabia. Evaluation results proved the effectiveness of this VR-Lab tool in e-learning. Some of the 3D graphics and animation results; using the VL Lab tool experiments; are given and investigated in details. Using these VR Lab facilitates can improve quality of education by increasing attraction of educational subjects.

1. Introduction

Evolution of multimedia and Virtual Reality (VR) technologies opened new educational opportunities in graphics and animation architecture and in engineering education. This paper describes some examples in these two educational fields. Several computer based teaching materials based on VR are presented in the literature [1-3]. Multimedia is the use of several different media (e.g. text, audio, graphics, animation, video, and interactivity) to convey information. It also refers to the use of computer technology to create, store, and experience multimedia contents. The use of computers to present text, graphics, video, animation, and sound in an integrated way can offer new opportunities in educational environment. With increases in performance and decreases in price of the hardware and software, multimedia is now commonplace. Some other e-learning working models are developed also to be useful tools for teaching numbering systems for learners [4], and in [5] the authors used an interactive learning tool in the theory of computation course. In [6]
an adaptive 3D Virtual Environment for Learning the X3D Language is also presented, it explains 3D graphics programming and applications. Allocating to e-course materials adaptively due to student learning styles are also discussed in several other working papers [7-11], and will also be tackled in details in this paper.

In this paper, the researchers present a new design and implementation for an adaptive E-Learning “Web Based VR Lab Tool” that can be used for teaching VRML 3D graphics and animation. This graphics VR lab tool can be used effectively for teaching postgraduate students in schools and universities.

2. VRML Characteristics and Teaching Environments

The Virtual Reality Modeling Language (VRML) [12] is capable of representing static and animated dynamic 3D and multimedia objects with hyperlinks to other media such as text, sounds, movies, and images. VRML browsers, as well as authoring tools for the creation of VRML files, are widely available for many different platforms. VRML supports an extensibility model that allows new dynamic 3D objects to be defined and a registration process that allows application communities to develop interoperable extensions to the base standard. There are mappings between VRML objects and commonly used 3D application programmer interface (API) features.

VRML is a file format for describing interactive 3D objects and worlds. It is designed to be used on the Internet, intranets, and local client systems. It is also intended to be a universal interchange format for integrated 3D graphics and multimedia. VRML can be used in a variety of application areas such as engineering and scientific visualization. Multimedia VRML has been designed to fulfill the following requirements:

1- Authorability: Enable the development of computer programs capable of creating, editing, and maintaining VRML files, as well as automatic translation programs for converting other commonly used 3D file formats into VRML files.
2- **Composability:** Provide the ability to use and combine dynamic 3D objects within a VRML world and thus allow re-usability.

3- **Extensibility:** Provide the ability to add new object types not explicitly defined in VRML.

4- **Implementability:** Capable of implementation on a wide range of systems.

5- **Performance:** Emphasize scalable, interactive performance on a wide variety of computing platforms.

6- **Scalability:** Enable arbitrarily large dynamic 3D worlds, presentations, entertainment and educational titles, web pages, and shared virtual worlds.

The aim of VRML is to bring to the Internet the advantages of 3D spaces, known in VRML as worlds whether they compromise environments or single objects. These are built to be shared between widely distributed users. Virtual reality have potential applications in many architecture and engineering applications which include the ability to test ideas in "real time" in a "three-dimensional" space during the design process:

- **Marketing tool** [13] (for example, interactive adaptive displays, to demonstrate the use of different finishes on a building);
- **Communication tool** [14], cross distance and language barriers (for example, between the architect and client, and to educate architects and engineers);
- **Evaluation modeling tool** [15] (for example, to study effects of lighting - natural and artificial, to evaluate acoustics phenomena, to simulate the properties’ of the material);
- **Modeling/Design tool** [16] (for example, to analyze spaces by actually "getting inside them", to Incorporate rational data during schematic design stages, then look at different design solutions, to design "virtual architecture" and “virtual prototype”).

3. **Evolution of 3D Graphics on Web Pages and Internet**
The features included in the VRML environments on Internet can include many facilities such as the following:

1- **Existence**: Users can feel that he is the main character in the virtual environment to a certain extent.

2- **Multi-Sensory**: In addition to visual perception, users can also feel the virtual environment in auditory perception, sensing, motion perception and sense of smell through some perception equipment.

3- **Multi-users**: The standards for the development of virtual environment can be established for multiuser, in which it can allow the users to communicate with each other in the virtual space.

4- **Interactivity**: VRML graphic real-time leads to that the man-machine can be interactive in the virtual scene.

5- **Dynamic display**: The virtual environment can be watched on the browser in any way from any point of view, which is the fundamental difference between VRML and other dynamic display language. The dynamic display has nothing to do with the network. The trick in the VRML is that through the internet it is only transmission the VRML file the capacity of which is limited, and just puts the frames of animation on local generation.

6- **The visual three-dimensional effect**: VRML scenes have created a virtual three-dimensional sense of reality, particularly in that light of the virtual object and property location would change with the movement of the mobile operator to enhance three-dimensional effect. At the same time, VRML can also make people feel the environment by using 3D sound voice in order to increase the authenticity.

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4. **Adaptive e-Learning & Teaching to Different Learning Styles**
Every individual student prefers to concentrate and absorb information in a different way, and their learning potential is vastly enhanced when they can do this in their favourite conditions. Learning Styles are the way a person takes in, understands, expresses and remembers information; the way a person learns best. The following documentation has been designed to assist teacher in identifying the individual learning styles of students as well as planning activities for the class as a whole, meeting the needs of our students. According to [17-18]; as shown in Leaning Pyramid Figure 1; Individuals Learn 10% of what they read, 20% of what they hear, 30% of what they do, 50% of what they both see and hear, 70% of what they discuss with others, and 80% of what they experience personally, and 95% of what they teach others.

![Leaning Pyramid](image)

Figure 1 Leaning Pyramid. Show average retention rates for learning activities.

### 4.1 Different Learning Styles

According to [19], learning styles can be classified as follows:


3. Verbal (linguistic): You prefer using words, both in speech and writing.

4. Physical (kinesthetic): You prefer using your body, hands and sense of touch.

5. Logical (mathematical): You prefer using logic, reasoning and systems.

6. Social (interpersonal): You prefer to learn in groups or with other people.


### 4.2 Leaning Style Questionnaires

A Felder’s assessment questionnaire form is used, after the researchers have modified it depending on the properties of each learning style according to Honey and Mumford [18]. This is short and specific. It is suitable for the educational purpose that it has been designed for. Table 1 illustrates a comparison between several well-known methods and the proposed one. Figure 2 shows the proposed questionnaire used.

<table>
<thead>
<tr>
<th>Table 1 Comparison between Leaning Style Questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey &amp; Mumford LSQ</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Multiple choice questions (2 choices).</td>
</tr>
<tr>
<td>Must answer all questions.</td>
</tr>
<tr>
<td>40 questions and in the last issue 80 questions.</td>
</tr>
<tr>
<td>General</td>
</tr>
<tr>
<td>(4 DIMENSIONS)</td>
</tr>
<tr>
<td>No time limit for filling out the questionnaires but it normally takes from 5-8 minutes.</td>
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<tr>
<td>-----</td>
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<tr>
<td>Questionnaire used for students</td>
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<td>---------------------------------</td>
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<tr>
<td>1. I understand something better after (a) Try it out. (b) Think it through.</td>
</tr>
<tr>
<td>2. If I were a teacher, I would rather teach a course (a) That deals with facts and real life situation. (b) That deals with ideas and theories.</td>
</tr>
<tr>
<td>3. I prefer learn here and now. (a) True (b) False</td>
</tr>
<tr>
<td>4. I tend to (a) Understand details of a subject but may be fuzzy about its overall structure. (b) Understand the overall structure but may be fuzzy about details.</td>
</tr>
<tr>
<td>5. In a study group working on difficult material, I am more likely to (a) Jump in and contribute ideas. (b) Sit back and listen.</td>
</tr>
<tr>
<td>6. I like to be a useful (a) Often (b) Rarely</td>
</tr>
<tr>
<td>7. In classes I have taken (a) I have usually gotten to know many of the students. (b) I have rarely gotten to know many of the students.</td>
</tr>
<tr>
<td>8. When I start a homework problem, I am more likely to (a) Start working on the solution immediately. (b) Try to fully understand the problem first.</td>
</tr>
<tr>
<td>9. I like see the results of my work. (a) True (b) False</td>
</tr>
<tr>
<td>10. I am more likely to be considered (a) Careful about the details of my work. (b) Creative about how to do my work.</td>
</tr>
<tr>
<td>11. When I see a diagram or sketch in class, I am (a) The picture. (b) What the instructor said about it.</td>
</tr>
<tr>
<td>12. I bored with (a) Implementation (b) Long discussion.</td>
</tr>
<tr>
<td>13. I am able to explore the association and relationship between things. (a) True (b) False</td>
</tr>
<tr>
<td>14. I prefer discover examples based on the generalization and autonomous discovery. (a) True (b) False</td>
</tr>
<tr>
<td>15. Usually I like to deal with (a) Observations (b) Tactile</td>
</tr>
</tbody>
</table>

Figure 2 Leaning Style Questionnaires
4.3 Learning Styles Assessment

Learning styles assessment can be computed as shown in [20] where a preferred student learning styles can be determined using radar chart as shown in Figure 3, as follows:

1- Pin point the results of your preferences from the relative strengths chart using questionnaire form [18] and place it on the plot line in each Learning style, on the Radar Chart below Figure 3.
2- Connect each plot by drawing a line between each preference.
3- Color in the area once each preference is determined.
4- Microsoft Excel can be used to draw the chart, as shown in Figure 4.

Figure 3 Drawing Learning Style assessments Radar Chart using Microsoft Excel.
Figure 4: Learning Style assessments Radar Chart.

5. Proposed VR Lab Tool Architecture

The proposed virtual reality Lab tool consists simply, as shown in Figure 5 of a multimedia e-Book contains VRML 2.0 Lab course contents. A lesson can be allocated adaptively to a student due to his learning style and course level knowledge. Then, the student uses the VRML editor available in the system for editing the graphic program. A file is then created with the extension .wrl. The web page designed contains 3D graphics Cortona Browser, which is used to view the file, and display the shape corresponding to that file.
In the learning environment the web site is made up of pages. Each web page consists of three frames, one for explaining the object, the second is to show the object in the VRML.
browser, and the third one is a button to the source code, as shown in Figure 6, [11]. The main home page uses VRML browser frame for navigating through 3D virtual environment. Another web page is used for guiding the student to choose the preferred way in displaying the tutorial (visual, verbal or physical, etc). Another four web pages are added in the visual page for learning the basics of the graphics and animation objects.

Figure 6 displays and explains Box Node.

5.1 VRML 2.0 e-Book Lab Course Contents

The proposed VRML 2.0 e-Book Lab Course Contents is designed and implemented taking into consideration the advantage of learning gain rates; explained in the learning
pyramid; that can be effectively achieved using multimedia teaching environments that are shown above in Figure 1. Taking this into consideration, the VRML 2.0 e-Book is implemented using multimedia software authoring tools [21]. The book contains the e-course of the VRML2.0 Language. It includes the e-course materials in the form of text format, graphics in 2D and 3D, as well as sound and video demos.

The VRML2.0 e-course is classified into three levels. **Level-1** consists of basic graphics element such as 3D box, sphere, cylinder, and other single geometry shapes. **Level-2**, contains complex 3D graphic shapes using transformation, translate, scale, and rotation. **Level-3** contains lessons to help student how to implement animated shapes including sound and light effects.

Student can be automatically transferred from one study level to the advanced one when he passes an exam. The exam is generated using an exam generator [18] and each course level contains 30 questions. It is allowed to a student to transfer to higher level when he achieved the score 80%.

**5.2 VRML Pad Editor**

The VrmlPad text editor [22]; shown in Figure 7; environment includes an integrated text editor to manage, edit, and print source files. Most of the procedures for using the editor should seem familiar if you have used other Windows-based text editors. With the Text editor, students can set and customize syntax coloring for source VRML files. The professional VRML text editor features include powerful editor abilities. Smart AutoComplete, dynamic errors detection, syntax highlighting, advanced find and replace, visual support for the scene tree, and VRML resource operations. Use AutoComplete for quick entering a VRML keyword, node type, node name, field name, default field value or another syntax element. Perform advanced find and replace operations in a file, including using regular expressions.
Among the Features and Facilities of the VRML Pad Editor are the following:

- Use virtual spaces for advanced cursor positioning.
- Navigate through sections of code using the Go To dialog box.
- Use Bookmarks to mark frequently accessed lines in your source file.
- Customize the Text editor with save preferences, tabs, and indents.
- Modify the font style, size, and color.
- Select lines or multiple lines, copy and cut selection into clipboard.
- Split the Text editor window into two panes.
- Hide a body of huge or uninteresting nodes and prototype declarations.
- Use drag-and-drop editing within editor window, and between the Text editor and other applications. It also uses Syntax coloring facility.

Figure 7 VRML_Pad Screen showing a cylinder VRML code.
Each VRML file:
- Implicitly establishes a world coordinate space for all objects defined in the file, as well as all objects recursively included by the file;
- Explicitly defines and composes a set of 3D and multimedia objects;
- Can specify hyperlinks to other files and applications;
- Can define object behaviors.

5.3 Cortona3D Viewer

Cortona3D Viewer [23] is a fast and highly interactive 3D viewer. A set of optimized 3D renderers guaranties the best visual quality on both PCs with the latest video-cards and those with more basic video card capabilities. Cortona3D Viewer (previously known as Cortona3D VRML Client) works as a VRML plug-in for popular Internet browsers (Internet Explorer, Netscape Browser, Mozilla, Firefox, etc.) and office applications (Microsoft PowerPoint, Microsoft Word, etc). At this time, the Cortona3D Viewer is available on the Windows platform. But Cortona3D is more than just a viewer! The powerful API allows for integration of Cortona3D into any third-party application supporting ActiveX technology. With Cortona3D, one can create a wide range of 3D applications – from visualization of scientific data to advanced 3D-enabled online services.
The Cortona3D Viewer Main features, as shown in Figure 8 perform the following:

- Complete VRML.2 support.
- Automatic installation for Internet Explorer.
- Support of modern 3D accelerators via DirectX and OpenGL.
- Advanced rendering: mipmapping, phong lighting, reflection mapping and enhanced anti-aliasing.
- Additional nodes and capabilities extending the VRML specification.
- Support for Macromedia Flash.
- Powerful API based on the ActiveX Automation technology.
- Customizable user interface.

Figure 8 Cortona3D Viewer screenshot.
5.4 E-Book Authoring Software

Several e-Book authoring software available in the market can be used easily to build the proposed VRML 3D Graphics e-Book, such as e-BookWriter [24]. A sample screen shot of this e-book is shown in Figure 9.

![e-BookWriter sample screen shot](image)

Figure 9 e-BookWriter sample screen shot.

Figure 9 shows the proposed overall e-book contents to implement the VRML 3D Graphics course. The e-Book is classified into main seven chapters, see Figure10 below.
6. Proposed Course Content Taxonomy

In order to enhance web-based courses, it is preferred to make the course material richer and more flexible, so that different students can get personalized content, and a personalized order of presentation. Figure 11 shows the proposed course content taxonomy used, where design of lesson content is tailored to individual users, taking into consideration specific learning style, analyzing coordination between student's learning style guidelines for preparing learning materials according to different learner's characteristics.
Meeting the needs of the students is the cornerstone of an effective program of "distance education"; it is the index by which the researchers judge where the effort that was made reached in this area of progress. An additional advantage of the proposed system is that, it takes up a massive number of teachers and learners efficiently and quickly, since it contains a control panel for administrator to determine rules of the beneficiary with more stability and predictability.

The system also allows the teacher to add chapters and lessons for the curriculum, as it can also add tests for the learned lessons. Moreover, it also allows the adding of an unlimited number of questions for the tests to classify the question's level: beginner, intermediate or advanced. It also allows the teacher to edit the personal data for students to make data editing easier and faster. Teachers will use the system to enrich or replace traditionally held lectures, supervise and support students, and simplify everyday tasks like sending announcements, assigning exercises, or grading.

Comparison between the e-learning and the traditional learning shows that, the e-learning will be effective when the methods and techniques used are suitable for the education process, when there is an interaction among the students and when the notes are exchanged between the students and the teacher from time to time, appropriately. We made sure that the educational system includes all of the properties that would achieve these properties. This educational system, in addition to the above, reveals the student's motivation style: Beginner (Level-1), Intermediate (Level-2) and Advanced (Level-3).
7. Results of some VRML Lab Training Experiments

The key benefits claimed for Web-based E-Learning approaches are:

- Flexibility of the learning with respect to time and space; adaptation to individual interest and previous knowledge; interactivity and dynamics; more effective presentation through multimedia; increased motivation.

- Support for different learning styles and learner types, access to distributed data; world-wide availability of education on highly specialized subjects.

- The establishment of learning-communities that overcome the isolation of traditional distance education.
The following Figures (12 to 18) show some results using the VR-Lab Tool experiments.

Figure 12 shows how to construct box and sphere VRML code.

Figure 13 shows how to construct box, cone, and cylinder and sphere VRML code.
Figure 14 two tables constructed using 3D graphics and transformation node.

Figure 15 shows a growing tree using 3D animation.

Figure 16 a robot that moves its hands.
Figure 17 constructing a moving Yacht [10] in the advanced course VRML 3D graphics and animation.

Figure 18 simulating Hajj Tawaf [9] process in Makah Mosque, a green counter is used to compute number of turns. The person who does Tawaf is colored in green.
7. Conclusion

The work introduced in this paper, shows the design and implementation of a virtual reality e-learning lab tool that can be used for teaching Virtual Reality Modeling Language (VRML) graphics and animation. This VR Lab tool is implemented using the commercial software available in the market, among these are e-Book multimedia authoring tools, VRML-Pad text editor, Cortona3D graphics viewer, it contains an adaptive VRML e-contents that are allocated according to students learning styles. The VR-Lab tool is used effectively for teaching postgraduate students in the advanced course of computer graphics at the faculty of computing and information technology, King Abdul-Aziz University in Jeddah, Saudi Arabia. Evaluation results proved the effectiveness of this VR-Lab tool in e-learning. Using these VR Lab facilitates can improve quality of educating by increasing attraction of educational subjects.

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