Interactive Introduction to X3D Graphics

Don Brutzman [1] and Craig Anslow [2]

[1]Naval Postgraduate School, Monterey, California, USA
[2]Victoria University of Wellington, Wellington, New Zealand

Abstract

Extensible 3D (X3D) graphics is a collection of open-standards that define a system that integrates network-enabled 3D graphics and multimedia. X3D applications are real-time, interactive, animated systems that can run in stand-alone or networked environments. This tutorial will focus on a commonly used subset of the complete functionality that is encoded in XML. X3D has three encodings XML (.x3d), Classic VRML (.x3dv), and Compressed Binary (.x3db). During the tutorial, the participants will learn hands-on how to build an X3D world, while getting a detailed understanding of the capabilities of X3D. Participants will also be given the latest X3D software development kit which contains a wide variety of free and commercial plug-ins, authoring tools, and content.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism

1. Outline

Extensible 3D (X3D) [WC04] graphics is a collection of open-standards that define a system that integrates network-enabled 3D graphics and multimedia. X3D applications are real-time, interactive, animated systems that can run in stand-alone or networked environments. The standards define an abstract set of functionality, three encodings (XML .x3d, Classic VRML .x3dv, and Compressed Binary .x3db), and two application programmer interfaces.

This tutorial will focus on a commonly used subset of the complete functionality using the XML encoding. The tutorial will cover X3D world creation using X3D-Edit, a Java-based free open source XML-based authoring tool. During the tutorial, the participants will learn hands-on how to build an X3D world, while getting a detailed understanding of the capabilities of X3D.

The tutorial covers the specific topics of polygonal and triangular geometry, materials and textures, interactive sensors, animation, prototyping, lighting, environmental effects and sensors, and web usage. The topics are illustrated with examples from the book, X3D: Extensible 3D Graphics for Web Authors [BD07].

2. Suggested Schedule

Time	Topic
8:30-10:15	Introduction, Foundation, Grouping and Coordinate Systems, Geometry I
10:30-12:15	Color: Materials and Textures, Animation
1:45-3:30	Geometry II, Scripting and Prototyping for Extensibility, Lighting
3:45-5:30	Web Usage, Case Study, Applications,

1. Introduction (0:10)
2. Technical Foundation (0:30)

    a. Coordinates and Axes
    b. Scene Graph
    c. Profiles and Components
    d. Files and Networks
    e. File formats
    f. Author and browser tools
    g. External Resources

3. Grouping and Coordinate Systems (0:25)

    a. First world
    b. Grouping
    c. Transform

4. Linear and Polygonal Geometry (0:25)

a. Standard Shapes
b. Lines and Points
c. Face Sets
d. Extrusions
e. Elevations

5. Q & A Hands-on (0:15)

– Break –

6. Color: Materials and Textures (0:30)

a. Material Color
b. Image Textures
c. Movie Textures

7. Animation (0:60)

a. Time and Linear Interpolation
b. Touch and Proximity Sensors
c. Discrete Sequencers

8. Q & A Hands-on (0:15)

– Lunch –

9. 2D and Triangle Geometry (0:30)

a. 2D Geometry
b. Triangle Geometry

10. Scripting and Prototyping for Extensibility (0:30)

a. Definition and Use
b. Converting Existing Code
c. Building and Using Libraries

11. Lighting (0:30)

a. Basic Lighting Principles
b. Light Types
c. Working With Lights

12. Q & A Hands-on (0:15)

– Break –

13. Web Usage (0:15)

a. Add X3D to a Web Page
b. Serving X3D Files

14. Case Study: Visualizing Software in X3D (0:60)
15. Applications (0:15)

a. X3D Earth
b. Other Emerging Technologies

16. Q & A / Wrap-up (0:15)

The following figures show some of the applications that participants will be exposed to during the tutorial. Figure 1 shows the X3D-Edit authoring tool editing an X3D file. Figure 2 shows the city of Baltimore viewed in the Flux X3D browser within the X3D-Earth prototype application. Figure 3 shows a software visualization of a UML Class Diagram in X3D, and the associated Javadoc from a small Java program.

3. Tutorial Considerations

The tutorial has been designed as a full-day tutorial; however, a number of different tutorials can be constructed from this full-day tutorial. If the tutorial were reduced to a half-day tutorial, then approximately half of the topics in the schedule would be eliminated.

We are willing to consider other ideas that the review committee may have for restructuring the tutorial, including changing the level of difficulty to better accommodate the needs of the Eurographics tutorial committee.

It is important for the participants of the tutorial to have Internet access. If there is no Internet access, then this will reduce participants' experience and ability to access the web for additional content and information during the tutorial. Aside from access to the Internet there are no other special presentation requirements for the tutorial.

4. Background and Target Audience

All participants should have a basic understanding of graphics and 3D graphics as presented in SIGGRAPH 101. Previous experience with VRML or X3D is helpful but not required.

The ideal participant will have experience with building web sites and wishes to expand their capabilities to include real-time, interactive 3D graphics. Participants with knowledge in advanced topics in graphics will benefit from this tutorial by seeing how to export their capabilities to a common web infrastructure.

5. Tutorial Material

The tutorial follows the book X3D: Extensible 3D Graphics for Web Authors written by Don Brutzman and Leonard Daly. The tutorial does not depend on the book, but is excellent supplementary reading for the course.

Associated with the book is an extensive web site (http://x3dGraphics.com) which is freely available. The web site contains all of the book examples, screen captures, and code illustrating every aspect of the book.

In addition to the book's web site, a number of other web sites will be referenced. These sites contain X3D models, examples, useful authoring applications, and source code. The Web3D Consortium will provide a System Development Kit (SDK) DVD to all participants that contain some of the above material.

The above material will be used as external content for parts of the course, and as additional reference material throughout the course. No supplementary material will need to be published with the tutorial notes.
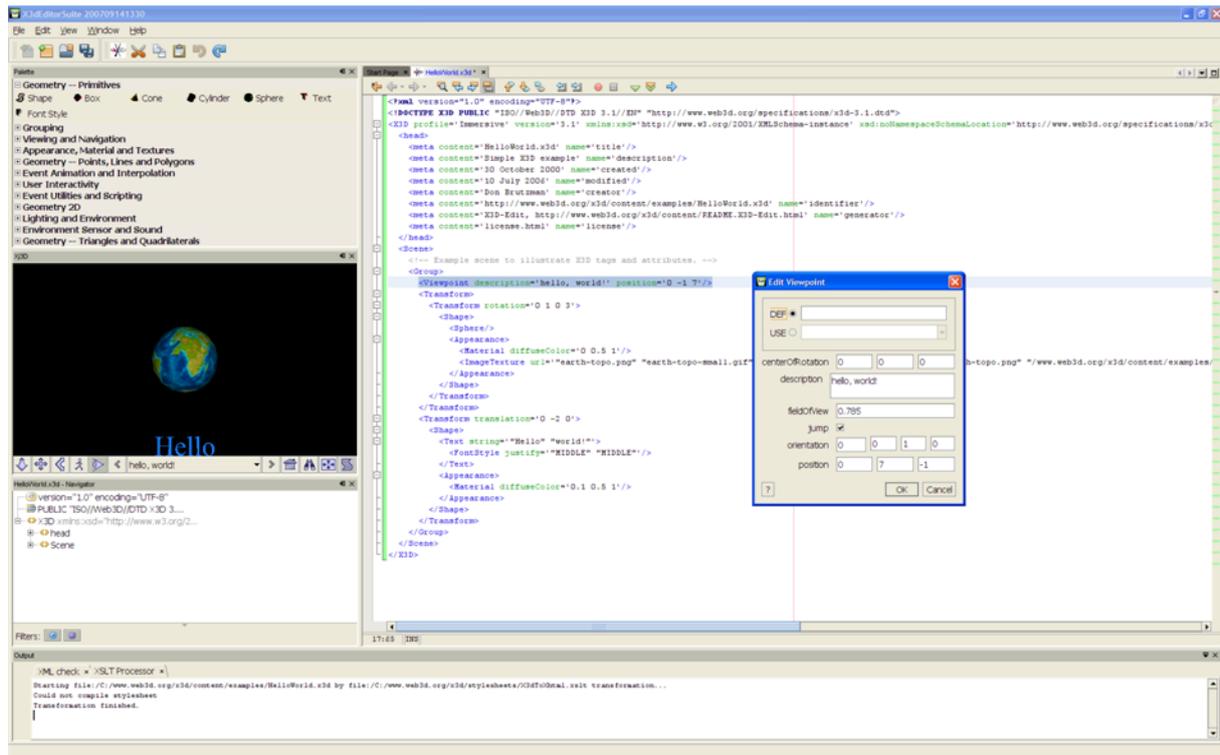
Figure 1: *X3D Edit.*

6. Presenter Backgrounds

Don Brutzman is a computer scientist and Associate Professor working in the Modeling Virtual Environments & Simulation (MOVES) Institute at the Naval Postgraduate School in Monterey, California, USA. He is one of the original participants involved with VRML since this community effort began in 1994. He is a founding member of the non-profit Web3D Consortium, serving on the Board of Directors. He co-chairs the X3D Working Group and leads X3D technical development efforts. He also serves as the Web3D liaison to the World Wide Web Consortium (W3C) Advisory Committee. He has been teaching VRML and X3D since 1996.

Craig Anslow is a PhD candidate at Victoria University of Wellington, New Zealand. He is a professional member of the Web3D Consortium. He has a BSc, BSc (Honours), MSc in computer science from Victoria University of Wellington. For his MSc thesis he evaluated X3D for use in software visualization [Ans07]. He has been programming in X3D since 2004. His PhD thesis area is visualizing software corpora and analyzing the visualizations to understand the shape of existing software.

7. Tutorial History

This course has not been taught at Eurographics before. Related courses were taught at SIGGRAPH 2002 and 2003. These older courses focused on other aspects of X3D. Since then the X3D specification has gone through one update and is in the process of a full revision. The material being presented in this tutorial represents the latest revisions in the X3D specification. The text book for this course was released in April 2007, and course materials are being taught on an ongoing basis.

References

[Ans07] ANSLOW C.: *Evaluating X3D For Use in Software Visualization*. Master's thesis, Victoria University of Wellington, 2007.

[BD07] BRUTZMAN D., DALY L.: *X3D: Extensible 3D Graphics for Web Authors*. Morgan Kaufmann, 2007.
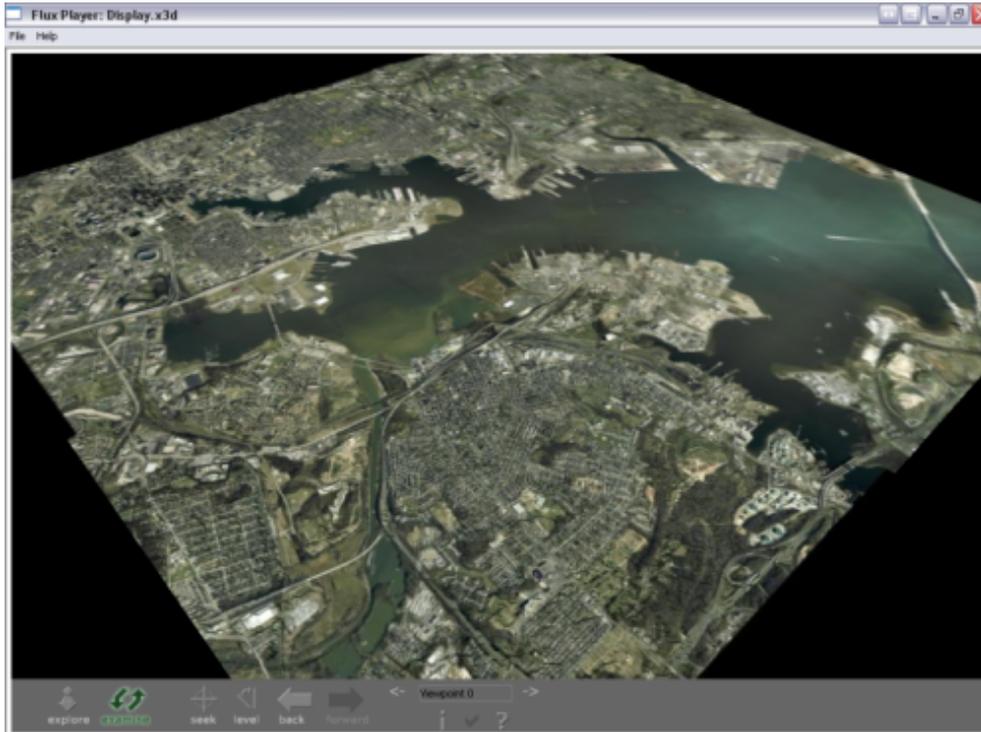
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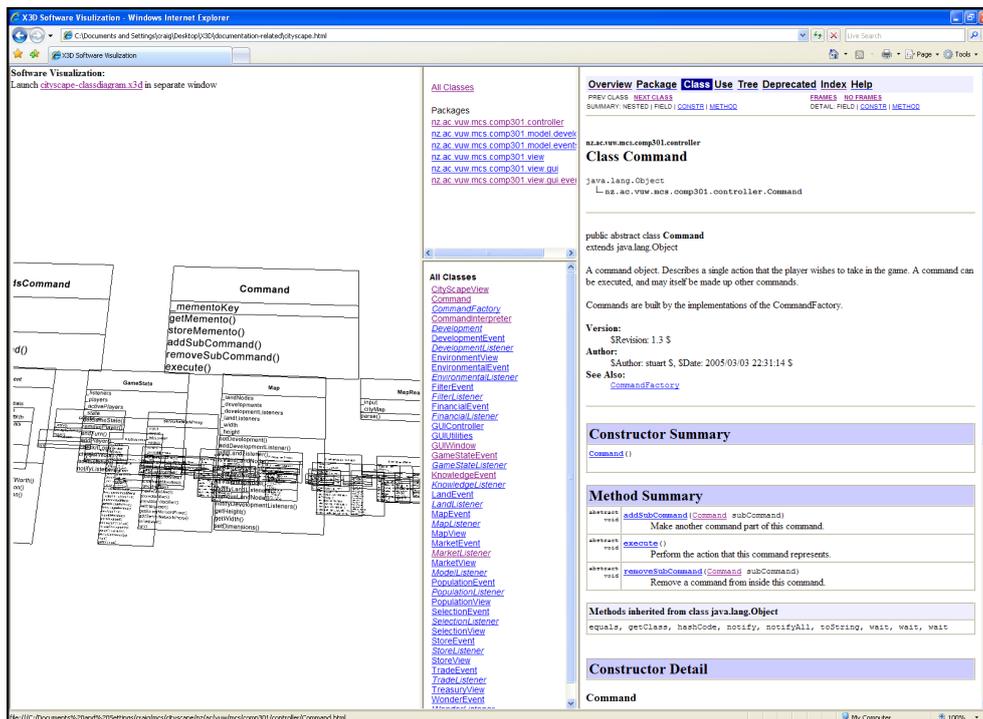
Figure 2: *X3D Earth.*

Figure 3: *Software Visualization in X3D.*