Learn X3D!

With Cases Studies and Examples

Web3D Webinar 8/4/2020

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Acknowledgements

Evolving material since 2018 with:

Johannes Behr
Timo Sturm
Uwe Woessner
The Web is Wide

Many Domains ... data
The Web is Deep

Open worlds linked can composed by URL
Interactive 3D Graphics + WWW = Web3D
A Rising Tide Lifts All Boats

Web3D Standards:

- 25 years of interactive 3D Graphics Innovation (& ACM SIGGRAPH Conference)
- A world-wide community
- Researchers Innovate
- Content & Applications Survive
VirtuWorlds Giza (1998-2020)

Early searches into 3D and Virtual Reality:

- Epistemology
- Metaphysics
- The Web
- Archival 3D
How it Works

- International Standards Organization (ISO.org)
  - National bodies ratify technology
- World Wide Web Consortium (W3C.org)
  - Members ratify technology
- Web3D Consortium (Web3D.org)
  - Members ratify technology
X3D 4.0 development is the center of discussion among Web3D working groups and community. We encourage members to participate in these important discussions as we extend X3D to make native authoring and use of X3D models fully integrated with HTML5.
www.web3d.org

- Globe & Weather
- Banner Worlds
- Case Studies
Foundations

- ISO standard, openly published and royalty-free
- A layer above media and rendering libraries
- Multiple implementations including open source codebases
- X3D Scene graph includes the *Transformation graph* and the *Behavior graph*

<table>
<thead>
<tr>
<th>Application</th>
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<tbody>
<tr>
<td>VRML, X3D</td>
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<tr>
<td>Open GL, etc</td>
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<td>Operating System</td>
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A Hypertext Markup for 3D: Extensible 3D (X3D)

• Like HTML, X3D has a content model that enables the spatial layout of media elements (images, audio, video, text) and links

• Like HTML, X3D is platform-independent

• Like HTML, X3D can be scripted with JavaScript

• Like XML, X3D XML uses a DTD and Schema
Scene Graph

- Lives above the rendering library
- Specifies object and environmental properties:
  - Lights
  - Camera
  - Transformation and Grouping of Shapes (parent - child)
  - Geometry and Appearance (materials, textures, shaders)
  - Environmental effects (e.g. Fog, Backgrounds)
- Manifests animation and interaction behaviors
- Is 'traversed' for drawing
ISO-IEC Standard Scope

Scene graph for real-time interactive delivery of virtual environments over the web:

- Meshes, lights, materials, textures, shaders
- Integrated video, audio
- Animation
- Interaction
- Behaviors
- Scripts
- Application Programming Interfaces

3.3 examples for Medical Imaging, CAD and Geospatial support!

https://www.web3d.org/standards
Resources

March 12, 2020:

‘X3D’
yields 20,700 documents in Google Scholar and 8,450 in Semantic Scholar

‘VRML’
yields 87,100 documents in Google Scholar and 24,000 in Semantic Scholar.
X3D Scene graph

Resources & International Community

www.web3d.org


Book:

http://x3dgraphics.com/

Online Slides: http://x3dgraphics.com/slidesets/index.php

Online Examples: http://www.web3d.org/x3d/content/#Examples
Playing Well on the Web

No spaces in file names!

X3D4 supports GLTF and PBR !!!

https://www.web3d.org/blog-integrating-x3d-and-gltf
Scenegraph

Lots of tools export:

- Virtual Reality Modeling Language (VRML)
- Extensible 3D (X3D)

... lots of other proprietary formats; can be converted with commercial translation tools, open source tools, or your own Scripts!

Target X3D Profiles and Components for different node sets (functionality)
Tons of Tools…

- Blender
- MeshLab
- 3DS Max
- Maya
- Rhino
- Paraview
- Agisoft
- ARCSscene
- Creoform
- PointFuze
- ...

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export me!

- Titania (Linux)
  [http://create3000.de/](http://create3000.de/)
- X3D-Edit
  [https://savage.nps.edu/X3D-Edit/](https://savage.nps.edu/X3D-Edit/)
- AOPT (w/ InstantPlayer)
- XML & stylesheets
- ...

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- 3DPrint Exchange
- POSTGIS
  [https://postgis.net/](https://postgis.net/)
- ...
- Okino Polytrans
- Safe Software
- ...
- ...
X3D Engines (installed) (July 2020)

- Instant Reality
- Covise/OpenCover
- V-slam.org (Unity, Hololense)
- Castle Game Engine
- FreeWRL
- H3D (Haptics, py)
- Octaga
- Xj3D
- BS Contact
- Coin3D
- X3DOM
- X_ITE
- NIH 3D Viewer

HTML5 + WebGL Javascript Polyfills:

- ...
Molecules

- Chimera
- VMD
- *Mol
- CML

...
3dprint.nih.gov

- Molecules
- Cells & tissues
- Anatomical models
- Prosthetics
- Labware
- ...

NIH 3D PRINT EXCHANGE
3D Printing Support

- CURA,
- Netfab,
- Shapeways,
- ...

Native support of X3D for 3D Printing
(including color and metadata)!

Can always convert to/from **STL** with tools like:

- Blender
- Meshlab,
- 3DPrintExchange
- ...
High spatial and temporal resolution body scans

www.3dmd.com

OBJ is not enough—need for rich metadata

X3D Authentication & Encryption
Zebrafish Brain Browser

- NIH and the Burgess Lab
- VT Undergrad Interns
  - clip plane
  
  example

Zebrafish genetic and neuro atlas: zbbrowser.com
Volume data

- Cell Image library
- Fossils (CT)

- Zoology (Prof Hoffmann, Bonn)
  - [http://vnhm.de/](http://vnhm.de/)

- VICOMTech:
  - MIRROR4All
US Navy Facilities: Worldwide

- X3D Database
- X3DOM client
- Video Link on Web3D.org case studies!!

- Interactive 3D Models in Geospatial Context
- High Velocity Group Learning Environment
X3D Blacksburg

Environmental Awareness E.g. https://youtu.be/ZIXbsR4KSzc

- Terrain
- Imagery, openstreetmap
- Town buildings
- Campus buildings
- Sketchup buildings
- Frog scans
- ...
Appalachian Trail

Remote site
Photosphere
viewsheds
Remote site visits
Design & Planning II

- **Virtual Tours**
  - photospheres
  - Structure.io scans
- **Town Planning** (Sketchup + X3D Blacksburg)

http://metagrid2.sv.vt.edu/~n polys/ForestFarming/McDaniels_NutGrove/grove1_Xb.html

http://metagrid2.sv.vt.edu/~n polys/3DBBurg/Cecile/Dec5/BBurg_AlleyV4_aopt_bin_Newnew.html
Design & Planning examples

Exhibits

Landscapes

https://vimeo.com/visionarium2018
Catawba GIS & tree LOD

http://metagrid2.sv.vt.edu/~npolys/Fusality_Summer2016/catawba_deer_hunting_x3d/

PointClouds and X3D Rendering

PointProperties in X3D 4.0

http://metagrid2.sv.vt.edu/~yansh93/archimedes_pp.html

http://metagrid2.sv.vt.edu/~yansh93/catawba_pp.html
More Cool examples

**Elphel** using open standards and open source!
Cameras : Product Catalog & **media products** in X3D!
eTrout Citizen Science

w/ USGS & WebVR VideoSpheres - count the trout!

http://metagrid2.sv.vt.edu/~npolys/eTrout/AI/index_sphere.html

https://virginiatech.qualtrics.com/jfe/form/SV_3KmmcAZmpC2Yw29

BioPax Ontology Vis

Peter J. Radics, Nicholas F. Polys, Shawn P. Neuman, and William H. Lund. "OSNAP! Introducing the open semantic network analysis platform". *Proceedings of Visualization and Data Analysis, IS&T/SPIE Electronic Imaging; 2015.*

http://vis.arc.vt.edu/projects/osnap/home.html
Particle Physics

Jefferson National Lab,
Center for Nuclear Femtography
CLAS-12 Instrument & Trajectories

https://youtu.be/TkrAqSFBgTE
http://metagrid2.sv.vt.edu/~oli1230/JLAB6/
Smithsonian Heritage + metadata in X3D

http://metagrid2.sv.vt.edu/~npolys/Web3DHeritage smithsonian/
Natural & Cultural Heritage

- Virginia Tech Insect Collection v.1
- Smithsonian Tests
- Virtual Natural History Museum: http://vnhm.de

- Australian National Insect Collection
  - https://www2.ala.org.au/chuong/

- ICONS of Greece
Interactive X3D Graphing

https://dlmf.nist.gov/

Online Vis + Sim Services

VRS - RAPID

https://www.youtube.com/watch?v=1Q2ytjBrmXc&t=1s

- **VRS-RAPID** is a collaborative, interactive, and 3D virtual-reality **web-application** for real-time simulation of nuclear systems.

- Users connect to VRS-RAPID to collaborate on **modeling and simulation** of e.g., nuclear reactors.

- Valuable tool for nuclear industry operators and regulators, educators and students, and continuing and professional training.
Going Immersive @ VT

Instant Player Engine files:
- Stereo Windows and Screens
- 3DUI as Javascript

InstantIO components:
- ART head, wand data
- DTK/TrackD (Intersense)
- Navigator

...
Experimental Design

Incident Report Data Analysis

Baselines: Demographics, Knowledge, and Cognitive Flexibility

Safety Interventions

Immersive Mixed-Reality Environment

Building the virtual model

Rendering at real scale using the ISO-IEC 19774 standard Extensible 3D (X3D)

Passive haptic: 2.4m-by-1.8m physical section of the roof with a 27-degree slope

Building the physical model

Two tracking targets (head-mounted on the glasses and ankle bracelet)

Adding virtual reality (VR) tracking tools

Synchronize the virtual and passive haptics

Log user behaviors

Add environmental effects

Worker's perspective from roof

Worker on the roof

Building the 3D model in Maya

Experimental Design

Presence, Mixed Reality, and Risk-Taking Behavior: A Study in Safety Interventions
Presence, Mixed Reality, and Risk-Taking Behavior: A Study in Safety Interventions
Engage!

- Standards make it work!
- Members drive features and Standards
- Expert Community
- Early Access to specifications
- Outreach opportunities

www.Web3D.org