VRML

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Topics
- History of VRML 97
- What is in it
- X3D

What is VRML?
- VR modelling language
  - NOT a programming language!
  - Virtual Reality Markup Language
- Open standard (1997) for Internet sharing of 3D files and Virtual Worlds
- A Scene description Language
- A file in ASCII or UTF-8
- The ancestor of X3D (standardised 2004)

The basic idea
- A website wants to use lots of 3D graphics..
- But sending 3D geometry, textures etc over the web is time and space intensive
  - Display systems on the client end vary anyway
- So send a markup description of the scene and render it locally
  - Incorporate the rendering software in the local browser as a plugin
What sort of markup?

- The markup must describe the scene graph
  - Geometry and textures
  - Groups and transforms
  - Lighting, Backgrounds, Fog, Level of detail
- It also needs to support interaction
  - Animation?
  - User interaction?

VRML Features

- Built-in geometric primitives
- Lighting, material, texture, movie control
- Spatialised sound
- Absolute time for animations
- Event-handling and routing
- Scripting
- Prototyping

History - 1

- 1994: Mark Pesce presents 3D Web Prototype
  - VRML email list established
- Open Inventor established as VRML basis
  - SGI
  - VRML 1.0
  - Supported static models only
- 1995: VRML Architecture Group (VAG)
  - request-for-proposals (RFP) for VRML 2.0

History 2

- 1996: VRML 2.0
  - based on SGI ‘Moving Worlds’ proposal
  - Included animation, user interaction and lots more..
  - VRML Consortium formed
- 1997: ISO Standard
  - VRML 97
Basic concepts

- Scene graph
  - hierarchical data structure: nodes and links
  - describes virtual world
- Nodes
  - shape, geometry, appearance, location etc
- Fields
  - each Node is a list of fields
  - contains values and parameters

Simple example

```VRML V2.0 utf8
Shape {
  appearance Appearance {
    material Material{}
  }
  geometry Sphere {
    radius 3.0
  }
}
```

Nodes

- Grouping nodes
  - Group, Transform, Collision, Billboard, Anchor
- Bindable nodes
  - Viewpoint, NavigationInfo, Fog, Background

Transform Node

- Transforms its children
  - applies in turn scales, rotations, and translations
- Transform nodes may be nested
  - but computationally expensive
- Negative scaling (for reflection) not allowed
Appearance Node

- Specifies visual properties of geometry
  - Material properties
    - ambient, diffuse, emissive, shininess, specular, transparency
  - texture
    - image, picture, movie

The Sound Model

- maxBack
- minBack
- maxFront
- minFront

Direction

Decreasing intensity

No Sound

Light Nodes

- DirectionalLight
  - At infinity, illuminates a scene with parallel rays, all from one direction
- PointLight
  - Located at a specific point in space
  - Illuminates from all directions
- SpotLight
  - At a specific point
  - Illuminates in a cone

Sensors

- Geometry sensors
  - CylinderSensor; PlaneSensor; SphereSensor; ProximitySensor; TouchSensor; VisibilitySensor
- TimeSensor
- Not sensors in the agent/robot sense
  - Only support user interaction
Interpolators

- For Keyframe Animation
  - position; orientation; normal; scalar; coordinate; color
- Each interpolator node has a set of keys and a set of keyValues
  - Keys are linked to a timer
  - Key values are routed to geometry at each key
- Provides piece-wise linear interpolation
  - So no curves!
  - How physically realistic is this?

Routing and Events

- Most nodes contain events
  - Incoming: eventIn
  - Outgoing: eventOut
- A ROUTE connects eventOut of a node to eventIn of another
  - Allows changes in one place - like a clock - to cause changes in another
- Results in field value being changed
  - Position, orientation, colour etc etc

Prototypes

- Create a custom node type
  - Use the PROTO declaration
- Or in an external file
  - use EXTERNPROTO to declare a reference
- Can be used to extend VRML

Script nodes

- For more complex interaction
- Usually contain JAVA or JavaScript
- Script node has eventIns, eventOuts and Fields
  - Code executing in a script node can change values in other nodes
External Authoring Interface

- EAI for interaction between VRML and JAVA applet
  - Different from the idea of a script node
    - Script node wholly within the scene graph
  - Supports interaction from outside of the scenegraph
- Requires browser to offer special classes
  - As part of its plugin architecture

Other Features

- Billboards
- WorldInfo
- NavigationInfo
- Level of Detail (LOD)
- Viewpoints
- Fog
- ETC

What is missing?

- Obstacle detection
  - only automatic for the user
- Sensors
  - in the agent sense of the term
- Support for autonomy
  - aimed at supporting the user as a privileged object

VRML Consortium

- Charter members included:
  - Blaxxun Interactive
  - Intel
  - Mitsubishi Electric
  - Platinum Technologies
  - Sony Corporation
  - Apple
  - IBM Microsoft
  - Oracle
### Working groups

- Lots and lots!
  - JAVA3D and VRML
  - Compressed Binary format
  - Living Worlds
  - Biota
  - Humanoid Animation
  - GeoVRML
  - ETC

### Creating VRML Worlds

- Text Editor
  - With bracket-matching support!
- VRML editor
- Many other modelling tools
  - with VRML File converter or exporter
    - This was often confined to VRML 1.0
- X3D-edit (free)
  - Locally installed in 1.53-1.54

### VRML Plugins/Browsers

- Parallel Graphics Cortona
  - The most widely used
- Media Machines Flux (X3D compliant)
- FreeWRL, OpenVRML - opensource browsers
- X3D
  - The Web3D free-standing visualiser
    - [http://www.x3d.org/](http://www.x3d.org/)
- Check at:
  - [http://cic.nist.gov/vrml/vbdetect.html](http://cic.nist.gov/vrml/vbdetect.html)

### More recent history

- VRML Consortium -> Web3D Consortium
  - Broader focus
  - All 3D web technologies
- X3D
  - Next Generation of VRML
  - Standardised 2004
Requirements

- Compatibility with existing VRML content, browsers, and tools.
- Extension mechanism to permit introduction of new features, quick review of advancements, and formal adoption of these extensions into the specification.
- Small, simple "core" profile for widest-possible adoption of X3D support, both importing and exporting.
- Larger, full-VRML profile to support existing rich content.
- Support for other encodings including XML for tight integration with Web technologies and tools.
- Architecture and process to advance the specification and technology rapidly!

Component-based architecture

- Profiles (as mpeg4)
- A collection of components, E.G:
  - CORE simple non-interactive animation
  - BASE compatible with VRML
- Components can be individually extended
  - Or new LEVELs added
- New components can be added
  - Formal mechanism for submission

Profiles

- Interchange profile
  - supports geometry, texturing, basic lighting, and animation
  - designed primarily to transfer data between applications.
- Interactive profile
  - adds additional lights, enhanced timing, and sensor nodes for interaction with the 3D environment.
- Immersive profile
  - adds audio, collision, fog, and scripting.
- Full profile
  - adds NURBS, H-Anim, and GeoSpatial components

Compatibility

- Any X3D-2 browser will play all VRML content
  - Add line: #X3D profile:base
- X3D-1 and X3D-2 content can be read into VRML apps
- XML support not essential
  - Just an additional encoding
Using XML syntax

- Links to other web apps
  - VRML syntax was unique
- Makes authoring more accessible
- Links to browser development
  - XML support in new browser versions
- Stylesheets for conversion
- File converters VRML <--> X3D

Xj3D

- Toolkit
  - VRML and x3d content handled entirely in java
  - Financial support from Sun
- Originally a VRML loader for java3D
  - Became main test bed for x3d
- Status
  - Version 1 2006 works on all main platforms
  - Now incorporated into X3D-edit as a visualiser

Conformance

- See www.xj3d.org/status.html
- Three renderers:
  - Java3D, OpenGL,mobile
- H-anim in OpenGL only right now
- Not all sensors fully implemented
- Extrusion in Java3d only
- Scripting is there and EAI in VRML
  - SAI still in progress

XML syntax
Other Technologies

- JAVA 3D
  - see the sun java site at sun.java.com
- Flash
- Shout3D
- Director
- MPEG-4 v1 includes VRML 97