

WebGL and the Three-D Internet

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Overview

The Vision: origins of cyberspace

The rendering problem

VRML: the grand attempt

XAML: the Microsoft web gets 3D

WebGL: what it can do

The Future?

The Vision

Prototypes in 1984

VR

Ivan Sutherland, USAF

Internet

ARPAnet running TCP/IP

MUDs and MOOs

Shared worlds with hundreds of users

All very expensive and/or exclusive

1984: “Neuromancer” by William Gibson

Keystone of the cyberpunk science fiction genre

Defined cyberspace

Cyberspace ... A graphic representation of data abstracted from the banks of every computer in the human system ...

Lines of light ranged in the nonspace of the mind, clusters and constellations of data ...

The 1990s VR Boom

VR no longer experimental

SGI purple workstations

VPL DataGlove, EyePhone

“Garage VR”

386 PCs with 3DFX Voodoo

Miniature LCD TV displays

World Wide Web

Internet beyond universities

The web grew exponentially

“Unthinkable complexity” now reality

The web was interactive

And hypertext was new

No physical equivalent, unlike email

The web user interface was primitive

Forms and round trip per page

“IBM 3270 with pictures”

What should it become?

套

INTERNET 2021

Johnny Mnemonic copyright Tristar Pictures 1995

The Other Plane

The road not taken

1981 “True Names” by Vernor Vinge

A world wide computer networked virtual reality

Magical metaphors: wizards and spells

Why didn't this succeed?

Fantasy outsells science fiction!

Client or Server Side?

Scene must be rendered

Model is geometry, textures, lights, materials, ...

Displayed as 2D raster image

As seen from viewpoint, digital camera

In realtime

Unlike CGI, don't control viewpoint

Where to render?

Model stored on server(s)

Displayed on client device

Client Side

Google Earth, World of Warcraft

Server sends 3D scene to client

Current room at least

Can use LOD techniques progressive download

Client renders with own GPU

3D accelerator before 2000

No round trip for interaction

Faster response to keyboard / mouse

Unless multi user

Disadvantages

Must write client side application

MacOS vs MS Windows vs Android ...

Must allow for different capabilities

RAM? Disk space? Screen resolution?

Must allow for different GPUs

NVIDIA vs ATI vs PowerVR ...

Shader Model 3? 4? 5?

Server Side

Server renders scene

Sends 2D images to client

Client tells server what resolution required

Client much simpler

Both hardware and software

Anything that can receive streamed video

Disadvantages

Round trip delay on all input

Even for single user case

Needs constant downstream bandwidth

Client side can handle slow initial download

Can't buffer stream to avoid jitter

User will not accept being 10 seconds behind

Can't use asymmetrical compression

MPEG etc not designed real time encoding

Extra copy back from GPU

Client side is CPU -> GPU -> display

Server side CPU -> GPU -> CPU -> network

Even Worse...

Server side 3D does not scale

Horrible context swap overhead

All textures and scene data stored in GPU RAM

Must reload for different scene

No virtual memory

Very deep GPU pipelines

Expect to run to completion on frame

Not designed for many short tasks

Need (almost) one GPU per user

For peak load, not just average

Electricity, heat dissipation

Server side doesn't scale

Client side is hard

(Cross platform applications always hard)

Web browser is “universal” client

Handles text and 2D (raster) graphics

Create HTML, no need for new applications

Example: E-book readers

Extend web browsers to 3D?

Create 3D scenes, no new applications?

VRML

Virtual Reality Modelling Language

Tony Parisi and Mark Pesce

Developed as open standard

VRML

First version static scenes

VRML 2 / 97

Animation and event handling

Javascript

Based on SGI Inventor

High level OpenGL library

Hierarchical scene graph

Nested transformations

DEF nodes for multiple parents

Geometry

High level: spheres, cylinders, ...

Low level: triangles, indexed face sets, ...

OpenGL 1 Gouraud shading

Point, directional, spot lights

Ambient, diffuse, specular material

Texture maps

Built in navigation

Walk, fly, or third person

Programmable viewpoints

Events and routes

User input, timers

Change transformations, visibility, properties

VRML 2: JavaScript

3D picking

Clickable nodes

Menus and buttons

Generate events

Integrated into web

Branches could be loaded from URLs

Single scene from multiple servers

Nodes could be anchors

Click on node, jump to new location

Including existing web sites

Superset of existing web

What Went Wrong?

Technology not ready?

Late 1990s PC were good at 3D

Internet bubble burst?

Web kept growing

Not multiuser?

Special viewers like Blaxxun

Maybe in VRML 3 ?



Google Search

I'm Feeling Lucky

A better solution to unthinkable complexity

VRML is not dead

Good interchange format

UTF-8, regular syntax

Matches OpenGL 1.x, DirectX 7 to 9

Good for special purpose programs

CSIRO haptic surgery programs

New viewers and plugins

Recommend Cortona 3D

XAML

Windows Presentation Foundation

Major redesign and rewrite of MS Windows APIs

Based on .NET managed runtime

2D / 3D for modern GPUs

XAML

Dynamic web programming, Microsoft style

WPF for web browsers

Could run on MacOS, Linux

Intended for viewing 3D models

Not VR or games

Extended XML syntax

Need arrays of floating point

Hierarchical scene graph

Nested transformations

Reference nodes with multiple parents

Geometry

No high level spheres, cylinders, etc

Low level: triangles, indexed face sets

Auto calculation of surface normals, tex coords

No GPU shaders

Point, directional, spot lights

Ambient, diffuse, specular material

Texture maps

Events and routes

User input, timers

Change transformations, visibility, properties

Integrated 2D text, graphics

Use 2D content as texture maps

Missing

Built in navigation

3D picking

Anchor nodes

WBAP

.NET web applications

Like Java, browser downloads and runs

XAML models loaded into app

More complex event handling

3D picking

Jump to new locations

What went wrong?



End of plugins

New era of mobile web

iPhone: no plugins

Obsoleted Flash, Silverlight as collateral damage

MS internal politics

.NET, WPF out of favour

MS very enthusiastic about HTML 5

No future for XAML?

Backwards compatibility only in Windows 8

No new versions

Not recommended for developers

WebGL

OpenGL API for JavaScript

SVG is API for 2D vector graphics

WebGL for 3D

New typed arrays for JS

VRML, XAML describe scenes

Retained mode

Data: can be stored, copied, exchanged

WebGL is code

Immediate mode

Programs, not documents

OpenGL 2 ES “Embedded Systems”

iPhone

Android

Consoles

3D assembly language

Points, lines, triangles

Texture maps

GPU shaders

That's it!

Missing from WebGL

Scene graph

No nested transformations

Can't attach scenes from other servers

High level geometry

No spheres, Beziers, quads

Built-in lights, materials

Have to write shaders

Advanced GPU capabilities

Geometry or tessellation shaders

Instanced rendering

3D picking

Extensions?

Traditional way to extend OpenGL

Runtime check for new capabilities

Yes ...

WebGL includes API for extensions

... No

Only official WebGL extensions

Not OpenGL V3/4

High entry barrier

OpenGL 2 API

and GLSL

Toolkits

“You can build exactly the high level functions you want”

Worked with jQuery for AJAX

Hasn't happened with desktop OpenGL 3/4

three.js, spider.js, ...

Does it have to be this hard?

Lines of code for shaded cube in web page

Single light source, diffuse material, no texture mapping

1997 VRML 14

2007 XAML 76

2012 WebGL 2,277

Availability (Dec 2012)

MacOS Safari

Most desktop Firefox

Most desktop Chrome

Some Android

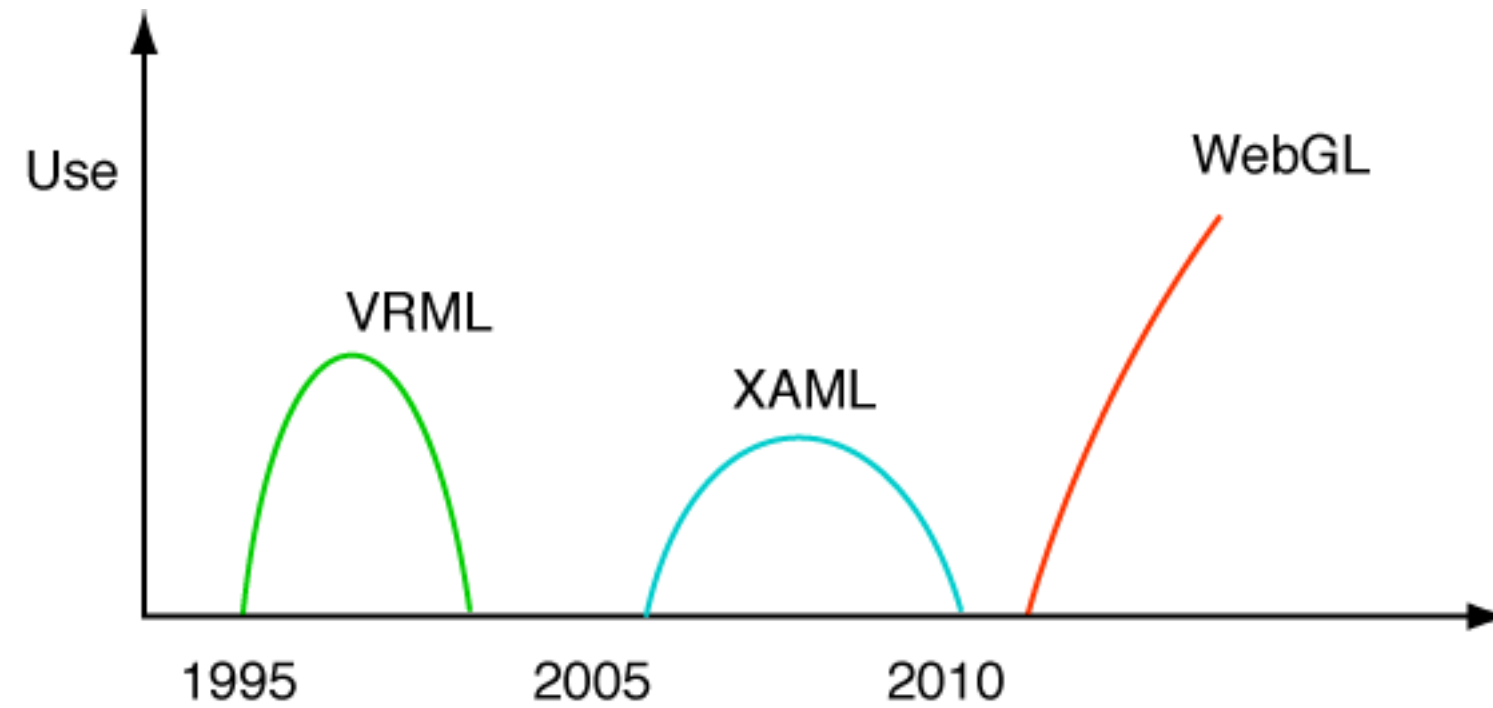
No iThing

Capability is there, Apple haven't enabled

No Internet Explorer

Plugins available

WebGL Growth



“60% of all statistics are made up on the spot”

WebGL will succeed?

Networks are better

Much more bandwidth available

Less need for compression, LOD schemes

GPUs are better

iPhone more powerful than SGI workstations

The web is much, much, larger

Soon a billion WebGL-capable smartphones

1% market will exceed best selling console games

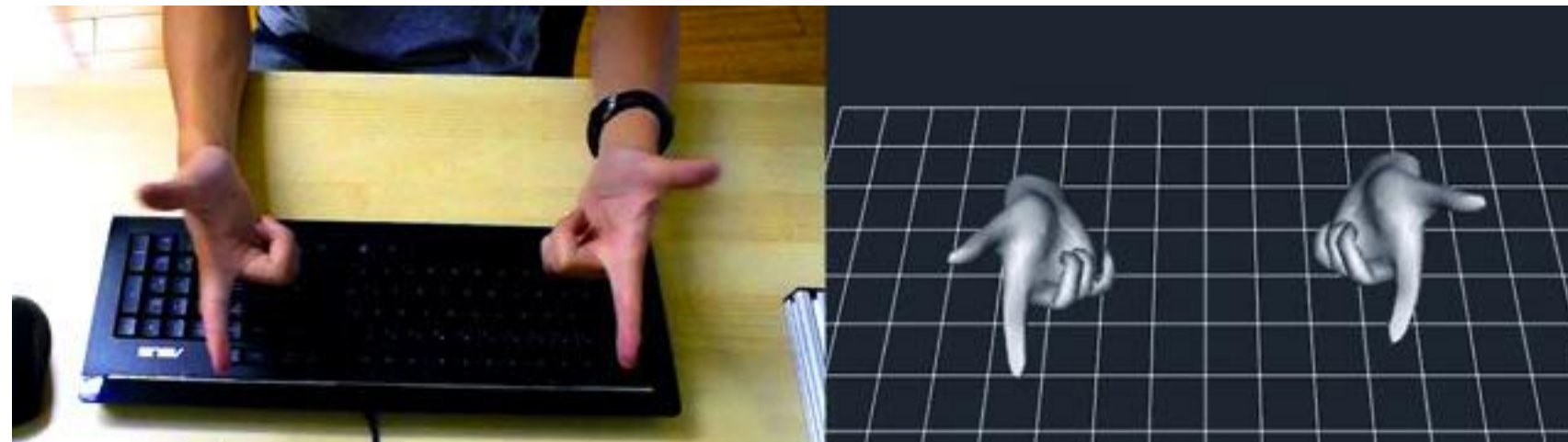
Internet 2021?



Google Glass

COURTESY: GOOGLE

Microsoft Kinect



learningwebgl.com

cs.anu.edu.au/~hugh.fisher/webgl/

Questions?