

How I learned to stop worrying and love the WEB3D



3DHOP FOR FUN AND PROFIT

MARCO CALLIERI

MARCO POTENZIANI

VISUAL COMPUTING LAB

ISTI-CNR PISA, ITALY

Who am I?



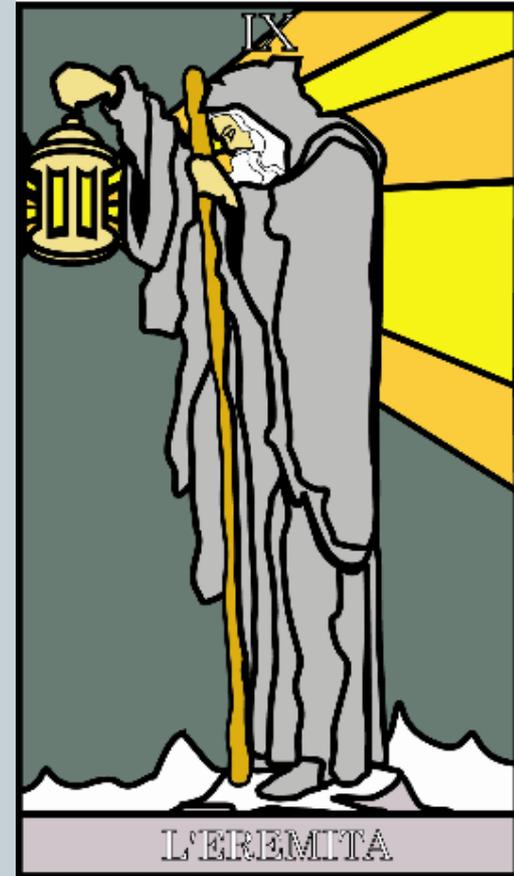
Marco Callieri

- Master degree & PhD in computer science
- Researcher at the Visual Computing Lab, ISTI-CNR, in Pisa
- I work on 3D data manipulation and rendering... lot of experience in 3D scanning and data processing
- Most of my activities are in the field of cultural heritage

callieri@isti.cnr.it

Beside this:

an eclectic artisan, an avid gamer, a former biker, a good cook, an incorrigible geek... and much more



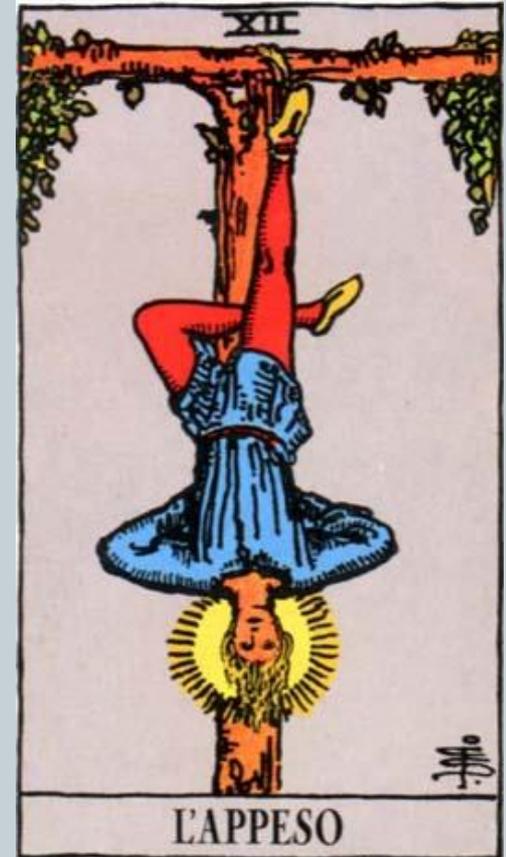
Who am I?



Marco Potenziani

- Master degree in engineering & PhD in computer science
- Researcher at the Visual Computing Lab, ISTI-CNR, in Pisa
- 3D scanning and processing
- CH applications
- 3D data visualization on web

potenziani@isti.cnr.it



Visual Computing Lab



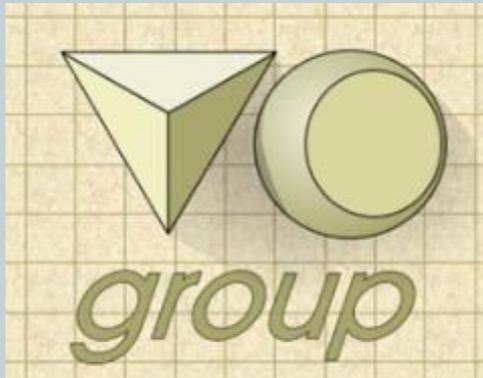
Research group working on **3D computer graphics**

part of:

Institute of Science and Technologies of Information (**ISTI**)

part of:

Italian National Research Council (**CNR**)



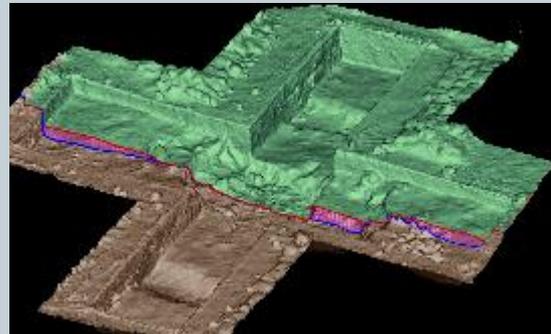
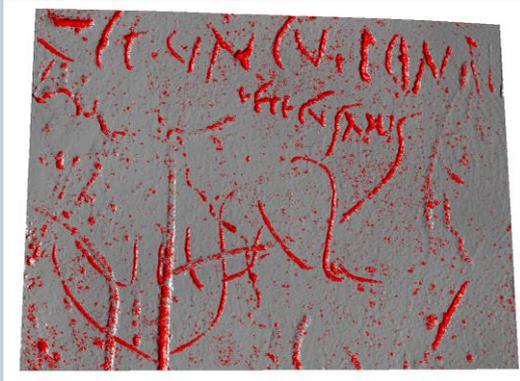
<http://vcg.isti.cnr.it>



Visual Computing Lab



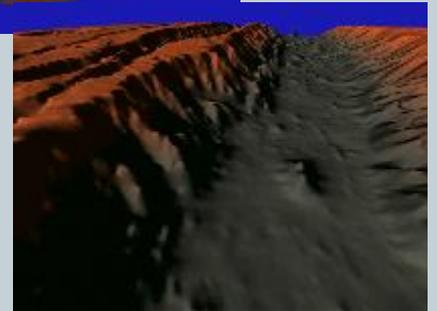
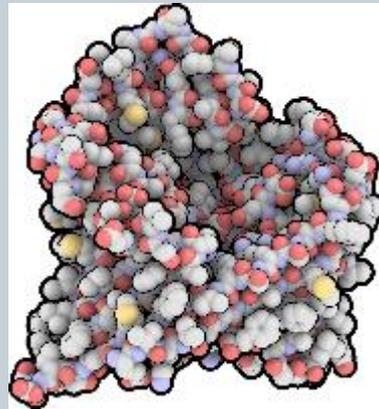
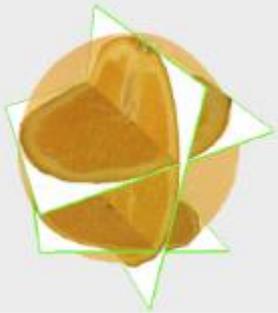
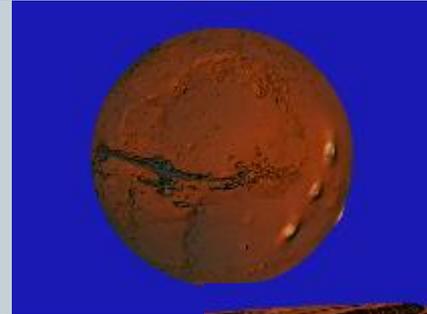
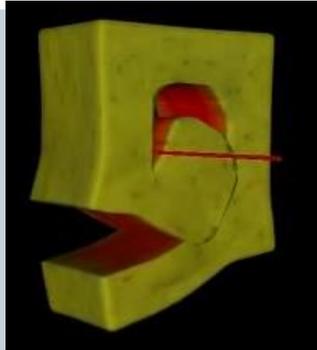
Cultural Heritage



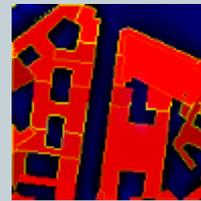
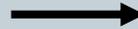
Visual Computing Lab



Realtime



3D

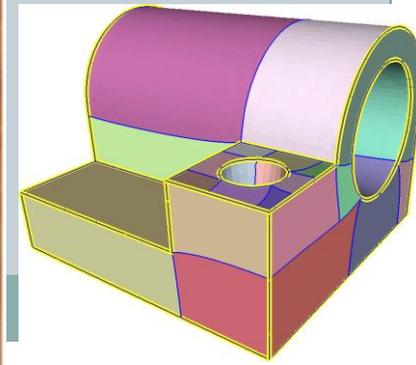
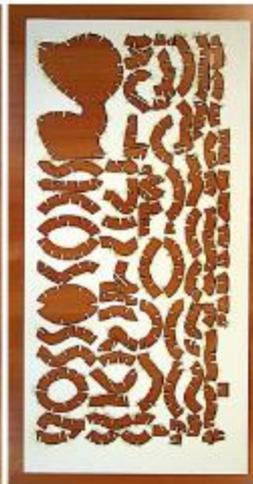
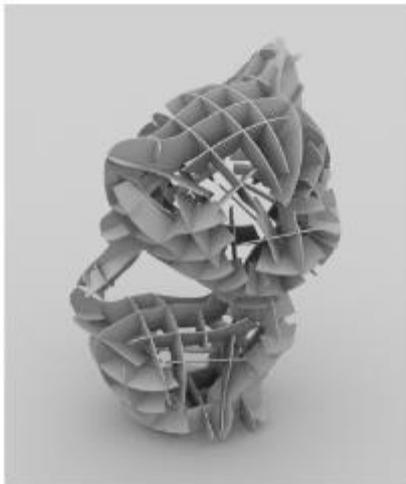
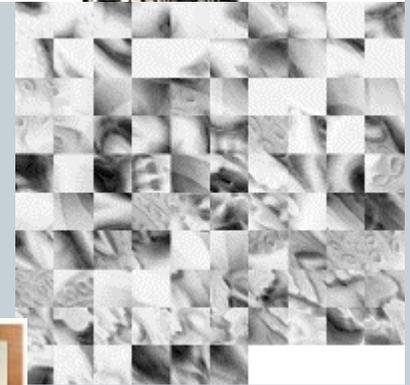
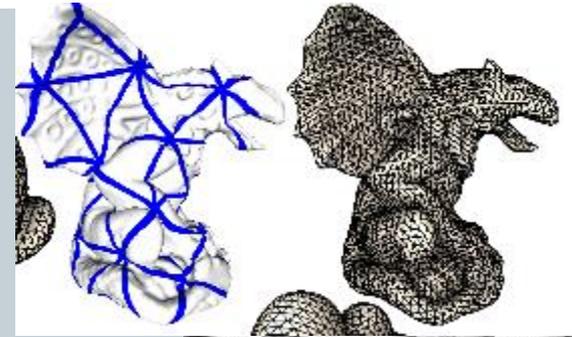
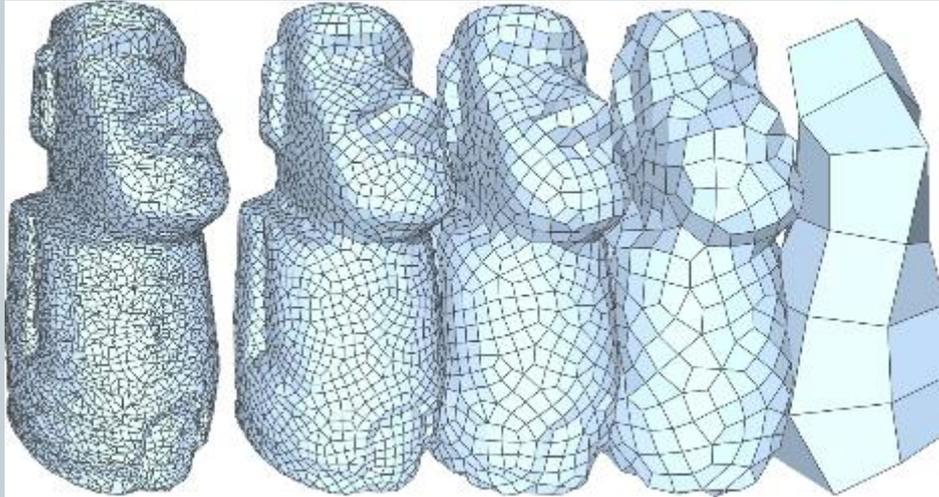


Texture encoding

Visual Computing Lab



Geometry Processing



Our Lab



We work in different practical projects (especially in CH), but we are computer scientists... So, beside methodologies, we work on software tools...

Beside custom tools for one-shot or internal use, we maintain set of tools for the community:

- **VCG Lib:** open source C++ library for 3D data structures management
- **MeshLab:** open source tool for 3D mesh processing, editing and visualization
- **3DHOP:** open source tool for 3D visualization on the web

Dark ages



3D on web



When the web was born, 3D was not considered as a viable media.

Text, images, sound, even videos, but not 3D

- Too early
- Too much data (non sequential)
- Too much complexity in handling it

3D was managed using plug-ins...

Plug-ins are evil



- Instability and performance issue
- Incompatibility and difficulty of supporting multiple combination of OS and browsers
- People do not like to install third-party software, and actually some plug-ins were malicious

Every company/research lab had its own plugin and format.
One after another they failed.

VRML

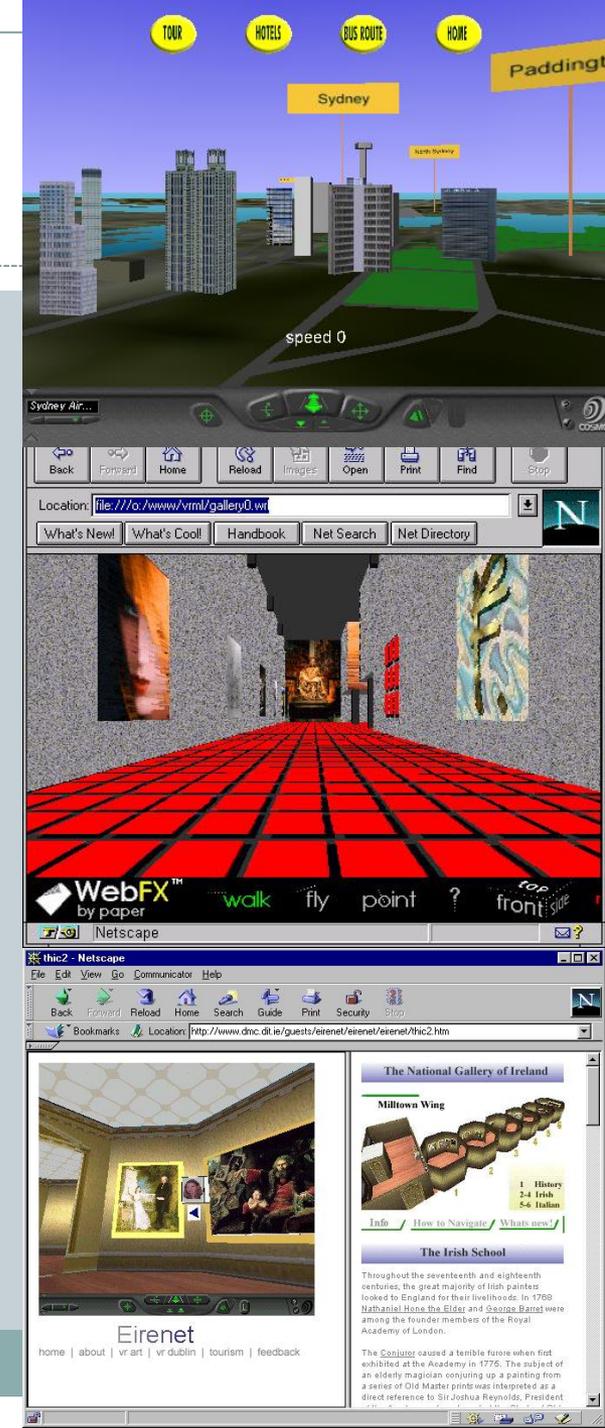


The iconic son of its time.

The age when we all believed the future of interfaces and digital was Virtual Reality.

Declarative creation of entities, plus behaviour associated to entities. It was somehow possible to connect the page events to the viewer events.

Remains today as a file format, plus other derivative tools/paradigms



A new age of enlightenment



WebGL



HTML5 came with a surprise: a way to display 3D data natively on the web.

WebGL is part of the HTML5 standard defining the JavaScript binding of OpenGL inside the browsers.

- Works natively inside the browsers
- Consistent across different browsers and OS (almost 😊)
- Has direct access to your graphics card
- Based on OpenGL ES2 (the standard for mobile devices)

WebGL



WebGL took the web by storm.

The presence of native 3D on web sprouted a sudden flooding of web apps working with 3D, open, free, freemium, and commercials.

Problem: WebGL is too low level to be used directly

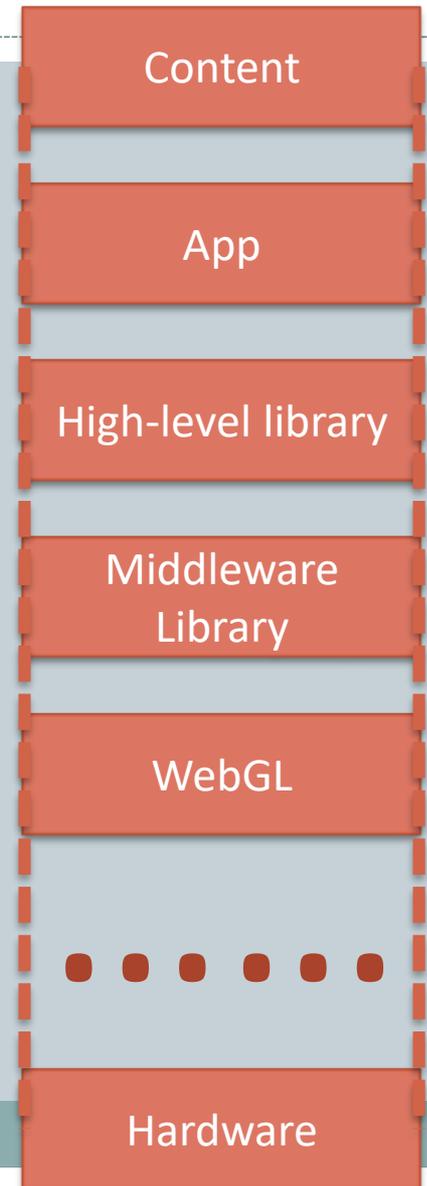
Web3D apps are like onions...



They have *layers*.

This is pretty common in software development, where the application is built by stacking a series of libraries / components with growing levels of abstractions.

This stratification makes difficult to classify and approach this world, and multiplied the number of actors, solutions and assets.



Web3D world



A “recent” survey / state of the art:

Publishing and Consuming 3D Content on the Web, A Survey

M. Potenziani, M. Callieri, M. Dellepiane, R. Scopigno

Foundations and Trends in Computer Graphics and Vision,
Volume 10 (4) – 2018

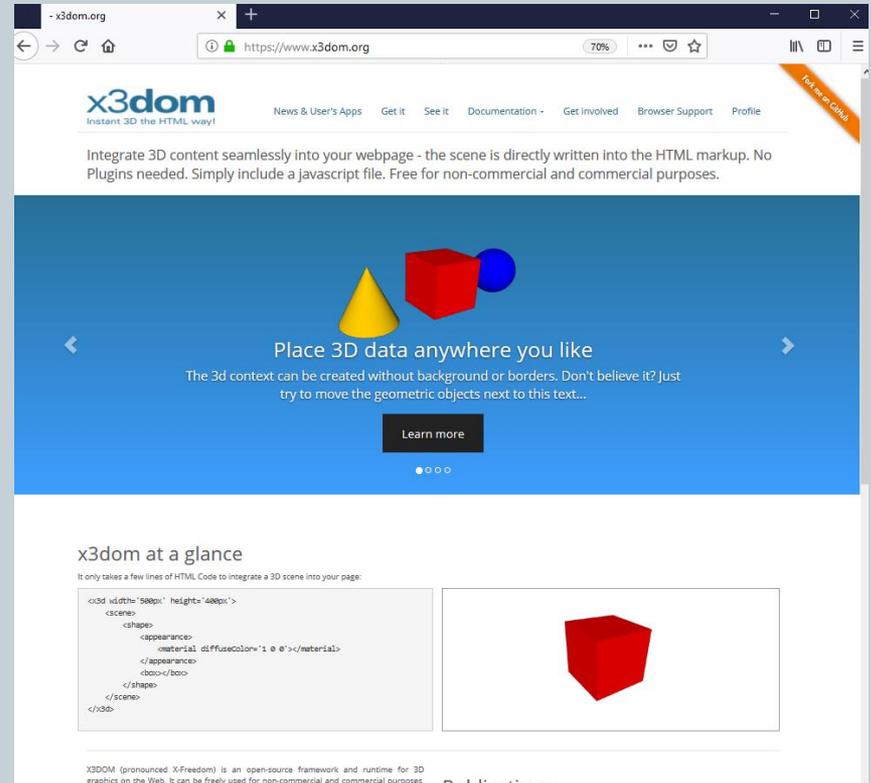
Preprint:

<http://vcg.isti.cnr.it/Publications/2018/PCDS18/>

X3DOM

Developer library

This is the heir of VRML.
More focused on HTML
developers, 3D entities are part
of the DOM. Strong accent on
the declarative approach



The screenshot shows the X3DOM website homepage. At the top, the logo "x3dom" is displayed with the tagline "Instant 3D the HTML way!". Navigation links include "News & User's Apps", "Get it", "See it", "Documentation", "Get involved", "Browser Support", and "Profile". A main heading reads "Integrate 3D content seamlessly into your webpage - the scene is directly written into the HTML markup. No Plugins needed. Simply include a javascript file. Free for non-commercial and commercial purposes." Below this is a blue banner with a 3D scene containing a yellow cone, a red cube, and a blue sphere. The text in the banner says "Place 3D data anywhere you like" and "The 3d context can be created without background or borders. Don't believe it? Just try to move the geometric objects next to this text...". A "Learn more" button is present. Below the banner, the section "x3dom at a glance" shows a code snippet for creating a 3D scene and a corresponding 3D rendering of a red cube.

```
<x3d id="t" width="500px" height="400px">
  <scene>
    <shape>
      <appearance>
        <material diffuseColor="1 0 0"/>
      </appearance>
    </shape>
  </scene>
</x3d>
```

X3DOM (pronounced X-Freedom) is an open-source framework and runtime for 3D graphics on the Web. It can be freely used for non-commercial and commercial purposes.

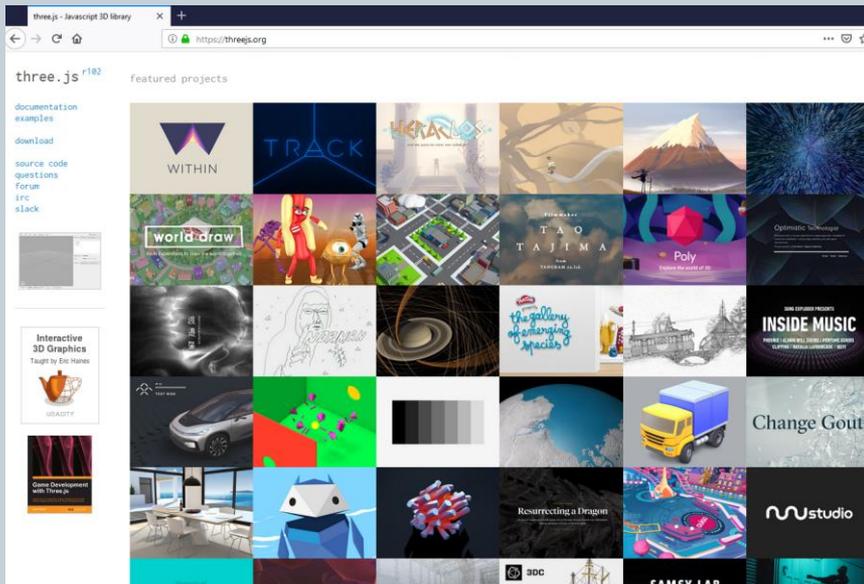
<https://www.x3dom.org>

Three.js



Developer library

More approachable for "classic" computer graphics developers. Entities and methods closer to what is available in game engines and CG libraries.



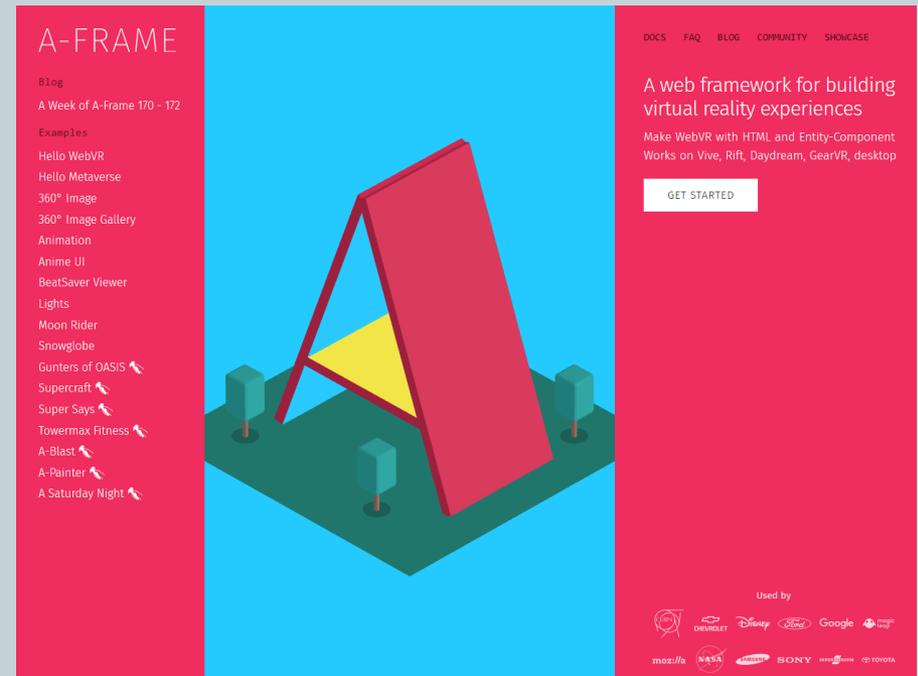
<https://threejs.org>

A-FRAME

Developer library

Oriented to WebVR applications. Many ready-made components, abstracting the basic elements of VR apps.

Built on top of Three.js



<https://aframe.io>

Going Up



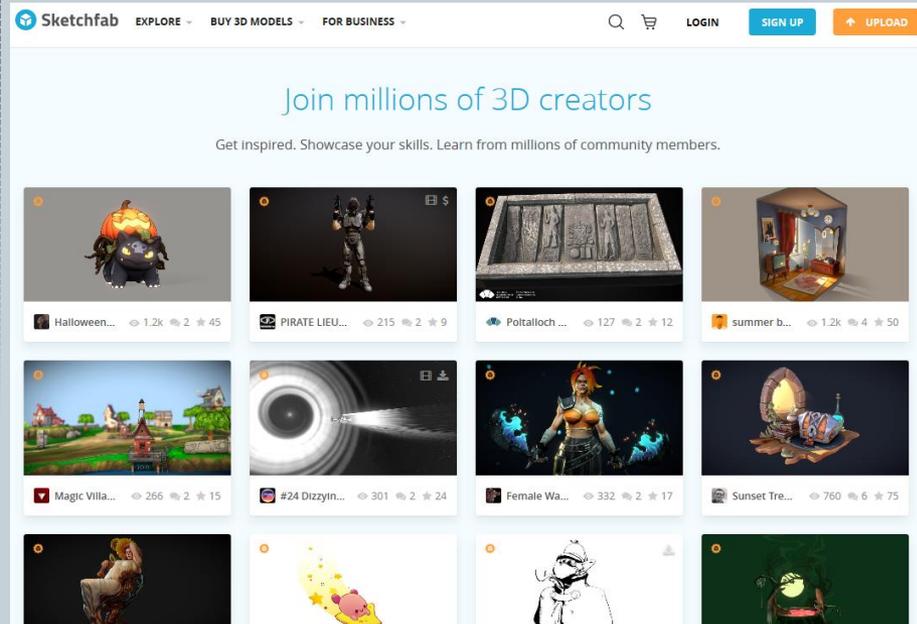
Sketchfab

It's YouTube for 3D models...

Really, this cover almost all that we need to say.

Freemium service with remote storage. Simple, super portable viewer.

Recently, started to be also a selling platform.



<https://www.sketchfab.com>

Potree



High-performances point-cloud web visualization.

Opensource, developed by a university. Able to work with huge datasets (multiresolution streaming). Viewer with advanced functionalities.

Download & deploy on your server

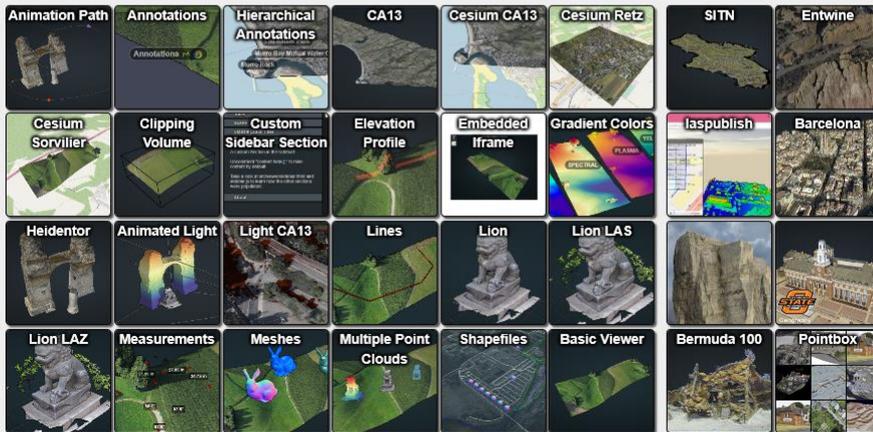
Potree Download Getting Started Donations Contact

About

Potree is a free open-source WebGL based point cloud renderer for large point clouds, developed at the Institute of Computer Graphics and Algorithms, TU Wien.

Examples

Third Party



<https://potree.org>

Smithsonian X3D

Smithsonian collaboration with Autodesk

At the moment, only available to the Smithsonian. Nice and fast rendering. The interface is a bit overwhelming for non-experts

The guided tour is a must-see feature



<https://3d.si.edu>

Not really on the same level, but



UNITY 3D

A full-fledged Game Engine, with a easy-to-use approach: drag assets, models and components to build simple interactive environments.

Among the many platforms, it is possible to export to web

Used A LOT in the CH world (it's free and portable), especially for reconstructions and immersive enviroments.

3DHOP



3DHOP



A tool for the web-based interactive presentation of high-resolution 3D models.

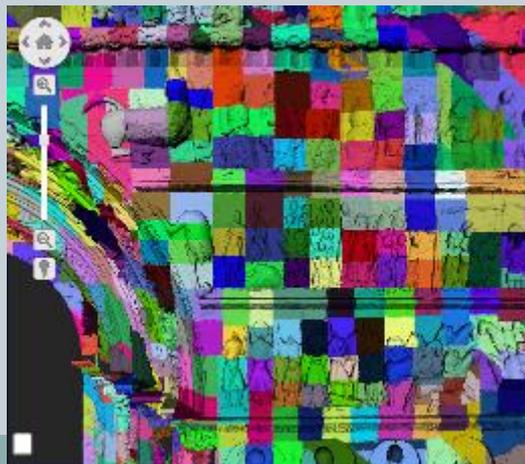
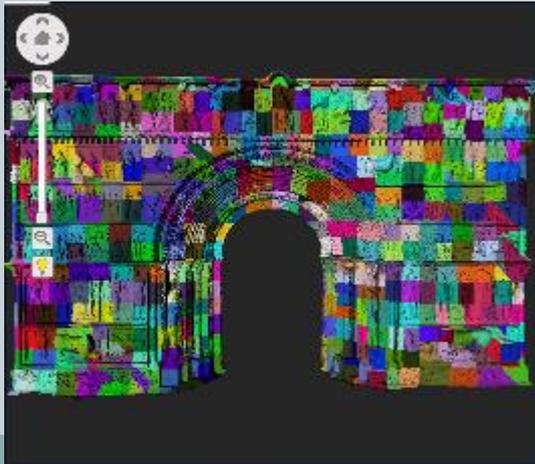
More precisely: a JavaScript framework with a set of configurable components.

- Based on HTML5 and WebGL, written in JavaScript
- Works in all modern browsers without plugins
- Designed to be easy to use and easy to learn
- Can deal with huge 3D models (10→100 Mtri)

Multiresolution



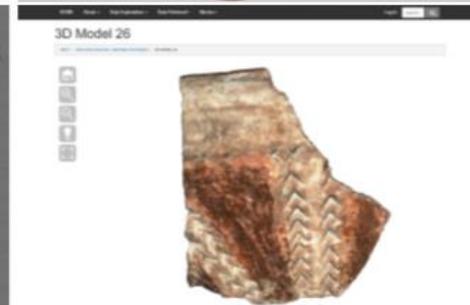
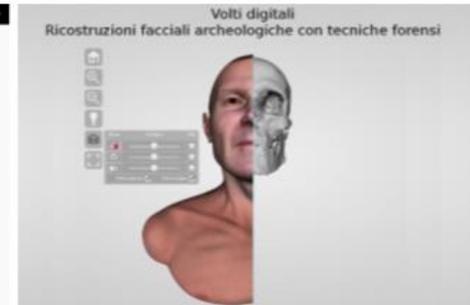
- The focus of 3DHOP is on managing high-res geometries, like the ones produced by 3D scanning or dense stereo matching...
- Triangulated meshes of 1 → 100 million triangles
- Model is preprocessed into a format which is streaming-friendly, and that can be efficiently rendered using a viewpoint-optimized mesh.



3DHOP



- Strong integration with the webpage
- Simple interaction with 3D data
- Fully customizable and extensible



What is 3DHOP ?



3DHOP has been designed to cope with the usual needs of the CH field: simple interaction, view animation, hotspots, visibility. The tool has a very simple configuration for the basic cases, but can also be heavily modified for specific situations.

3DHOP is open source, and is an active ongoing project, with regular updates and enhancements.

As it happened before with MeshLab, *3DHOP* is a software tool **WE USE FOR REAL** in our CH projects, that has been cleaned/polished in order to be usable also by others.

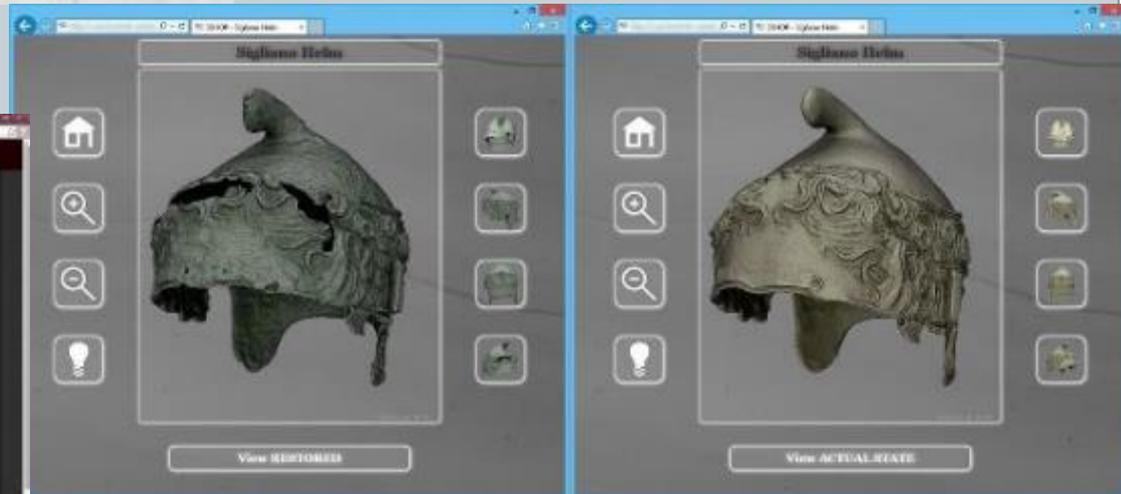
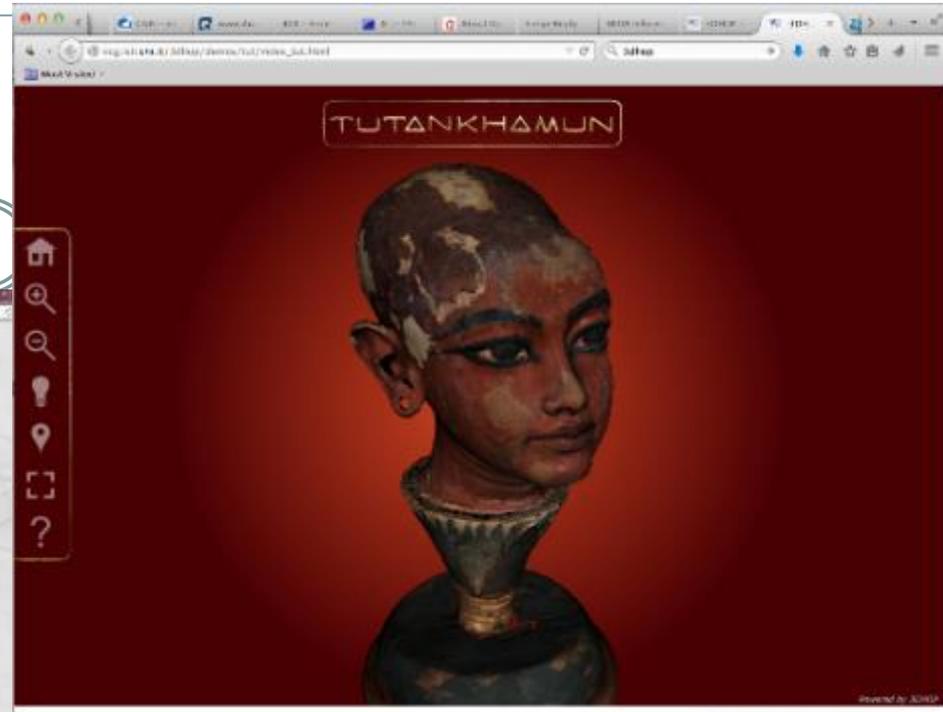
Aims and limits



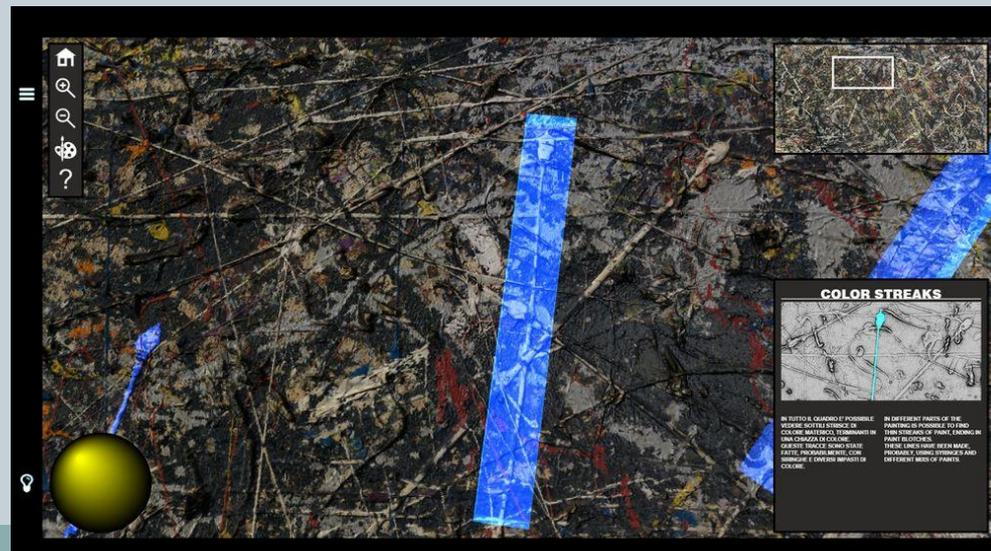
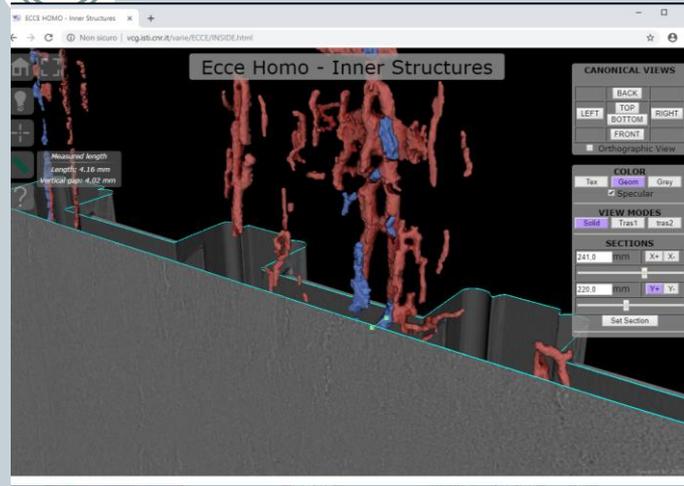
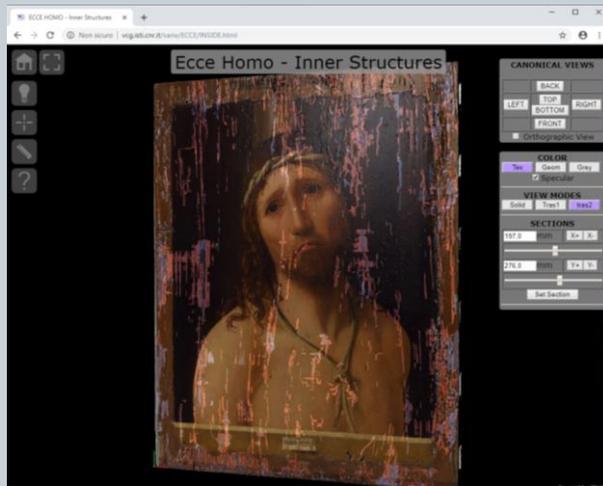
3DHOP is NOT a silver bullet... It is a very focused tool

- SIMPLE scenes made of COMPLEX objects, not COMPLEX scenes made of SIMPLE objects
- Works with “polygon soup” models, but not much with structured, CAD-like models
- Designed for FAST development and deployment, limits on the complexity of visualization schemes
- SIMPLE and IMMEDIATE interaction, impossible to make games
- Easy to use, but still requires HTML editing and JavaScript programming

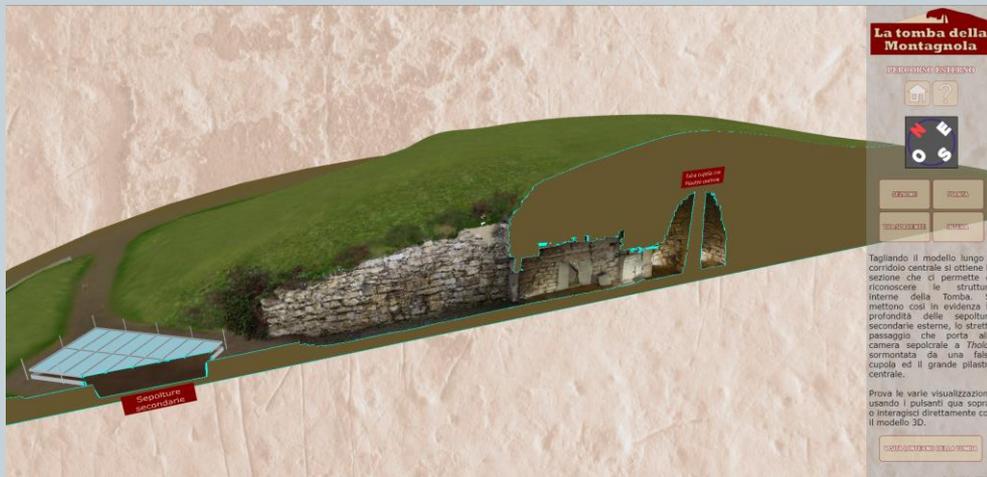
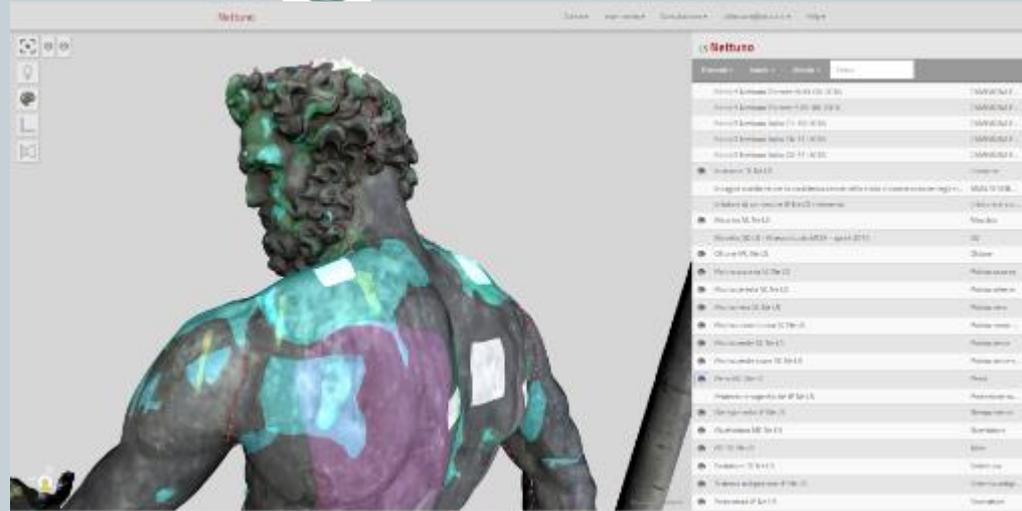
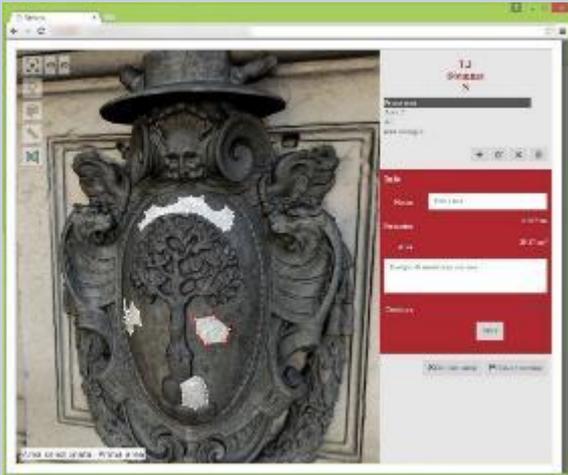
Easy stuff



Lots of customization work



However, coding additional components



Beyond 3DHOP



Without having to code

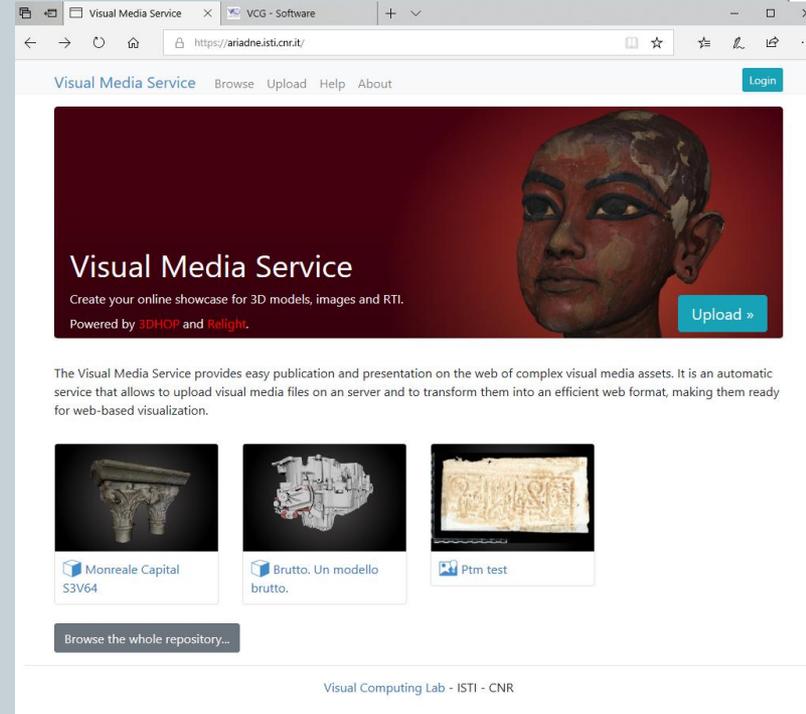


Visual Media Service

online repository with viewers for 3D models, RTI and large images.

Specialized, configurable viewers
Authoring tools for models/image
enrichment

<https://visual.ariadne-infrastructure.eu>



Nexus & Friends



Part of the potentiality of 3DHOP is the ability of working with high-res geometry.

3DHOP is a good piece of software, but it is not a solution for all the problems of the world.

So why not bringing the power of multires 3D into other tools/libraries/environments ?

- NEXUS in three.js
- NEXUS with Potree
- NEXUS in unity?

After 3DHOP, VR-HOP?



We already have a powerful multiresolution web-enabled engine...
Using WebVR and THREE.js we can build web-based VR apps using high-res geometry.

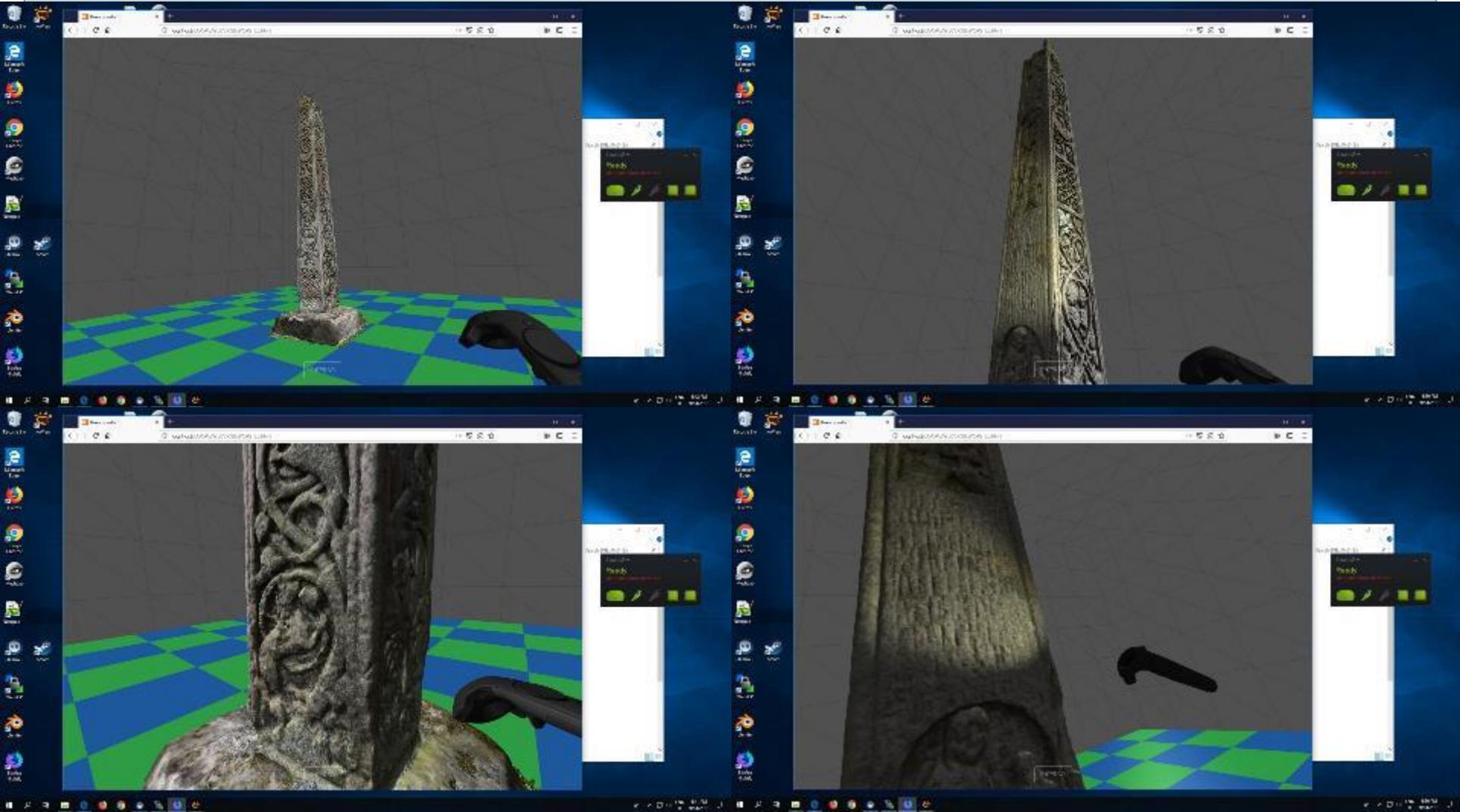
GOOD: works in streaming, works on many devices

BAD: you are completely on your own, same limitation of web apps.

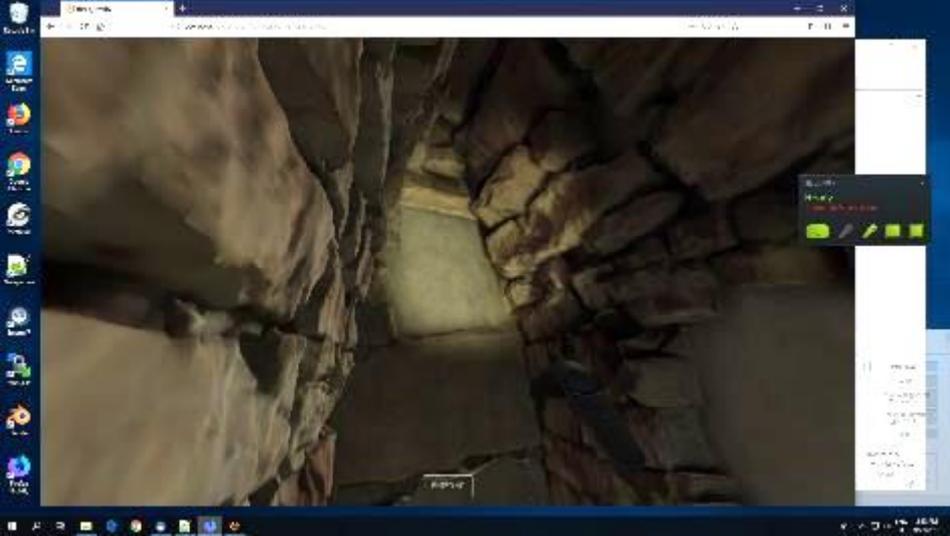
We created a «template» for simple scenes (much more limited than 3DHOP),
and for «explorable environments»



Basic scene



Indoor



Thanks for your attention...



CONTACTS & QUESTION TIME

callieri@isti.cnr.it

potenziani@isti.cnr.it

vcg.isti.cnr.it

www.3dhop.net

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