Publishing 3D contents on the Web: An Introduction

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Working with any kind of dataset always puts us in front of the same challenge: make that data accessible;

Why is it so fundamental to publish data? Actually... for several good reasons:
- Share the data;
- Validate the result of your work;
- Link knowledge;
- Spread information;
- Open the doors to collaborative work;

In this talk we’ll speak about the publishing of a specific kind of data, 3D data, on a specific environment, the Web.
Why 3D data?

- Because 3D data are the new media now, and a lot of cutting edge technologies are based on them (medical app, fabrication, CH solutions, VR and AR);
- Because acquiring or generating 3D data is becoming more simple and performing, both for active and for passive techniques (high precision scanners, 3D from drones, 3D from phones);
- Last but not least: because we knows very well 3D data!
Why on the Web?

- Because the Web is the better way to make something accessible to anyone anywhere;
- Because the Web is the most natural place where to link 3D data with the other media;
- Because to handle 3D data (possibly big complexity, huge disk space usage, poor standardization and elevated intrinsic heterogeneity) on the Web is a real challenge!
Let's start with a little tale...

- September 2013: Dr. Jonathan Roberts by Scientific Australian Agency CSIRO acquires the 3D model of the Tower Of Pisa.
- He uses an innovative portable 3D mapping system, and in only 20 minutes gets a point cloud of several million points.
- But working with 3D has not been always so easy...
To the origins of 3D, a brief history

- Hardware and 3D graphics:
  - At the beginning only specialized workstations;
  - Extremely limited 3D hardware enters the home in the late 80s;
  - Today: almost all devices equipped with graphics hardware more and more parallel and specialized;
To the origins of 3D, a brief history

- Software and 3D graphics:
  - At the beginning only specialized programs, mainly for research and scientific;
  - Then first video games (late 70s), low-cost productions, experimental cultural projects;
  - Today: entertainment (games, advertising, etc.), Cultural Heritage, support to visualization, ...
3D content as media

- Despite all the technological improvements, for a long time we could not define 3D content as a real media:
  - Contents generation not for everyone;
  - Contents use aimed only to specialized applications\audiences;
  - Inability to communicate with other media layers;
- ...so, in a nutshell: until then 3D could not be included in the “multi” of multimedia;
- The technological gap between 3D and other media was even more clear in the multimedia environment by definition: i.e. the Web!
Web and 3D

- First approaches:
Web and 3D

- Main limitations and issues of these approaches:
  - Plugin or cross-platform extensions (mandatory installation of third-party software);
  - Proprietary implementations (closed source code, inaccessible to the developers);
  - Heterogeneous solutions (sometimes even very different from each other);
- All that discourages developers and final users.
- Needing for a new standard for 3D on the Web...
In late 2009 time is ripe for a breakthrough, thanks to the progress in these three key factors:

1. Network infrastructure (Band: +9000% in 10 yrs);
2. GPU Hardware (Gflops: +9000% in 6 yrs);
3. Browsers software (JavaScript JIT interpreters);
Introducing WebGL

- WebGL (http://webgl.org) is the new standard for 3D graphics on the Web:
  - API (Application Programming Interface) that aims to use all the power of graphics hardware directly inside Web browsers using JavaScript interface;
  - Able to run directly in the browsers, without the need to install plugins;
  - Defined according to the specific OpenGL | ES 2.0 (OpenGL library for embedded systems);
  - Royalty-free and cross-platform.
WebGL in action
Using WebGL (for programmers)

- WebGL support tools (a non-exhaustive list):
  - GLGE (http://www.glge.org);
  - Three.js (https://threejs.org);
  - SceneJS (http://scenejs.org);
  - SpiderGL (http://vcg.isti.cnr.it/spidergl):
    - Developed by Visual Computing Lab;
    - Simplifies the WebGL use;
    - Light, powerful and flexible;
    - Provides a series of examples and HOWTOs;

- Other resources:
Using WebGL (for all the others)

- Thanks to WebGL nowadays all the main browsers have enabled 3D content native support:

- Unfortunately define a 3D scene on a Web page still remains not so easy action especially if you are not experts in Computer Graphics ...

- A lot of applications have been developed to overcome this issue and to fully exploit WebGL. Let's see the most important:
Introduced in 2009, X3DOM is a declarative development platform based on scenegraph, performing but not aimed at newcomers to CG.

X3DOM it provides native browser, plugin-free and independent 3D capabilities, and is designed to integrate closely with standard web techniques.

X3DOM is designed to integrate with the DOM (Document Object Model) and thus can be modified in the same manner as any DOM object.
X3DOM

- Link: https://www.x3dom.org
Unity

- Unity (2008) is a cross-platform game engine featuring advanced 3D graphics capabilities.
- Unity is very good for managing complex scenes consisting of simple geometries (3D modeling), not easily integrated with the Web page (it uses of a property plugin to run in the browser).
- Nevertheless, Unity's ease of use in creating a 3D scene and exporting it to a Web page, paired with its popularity among the public web merits its inclusion in this talk.
Unity

- Link: https://unity3d.com/webplayer
Sketchfab

- Sketchfab (2013) is a web tool and community, developed with WebGL, for 3D modeling and texturing, and is designed to allow 3D artists to share their creations seamlessly via the web.
- It has a lot of additional features, such as the ability to write comments and the possibility to view the model in different combined ways (wireframe, shaded, textured).
- Sketchfab is very simple to use, but with limitations and payment features for the handling of large 3D dataset.
Sketchfab

- Link: https://sketchfab.com
Smithsonian X3D

- Autodesk has worked in conjunction with the Smithsonian Foundation to deliver (in 2013) the Smithsonian X3D, a WebGL virtual heritage tool for the online visualization of 3D scans.
- It has many features common to 3D tools, such as the choice between wireframe or shaded view, textures, and advanced real time materials, but it also provides the possibility to alter the lighting of the scene in a very direct and easy way by defining light sources around the surface of a virtual dome.
Smithsonian X3D

- Link: http://3d.si.edu
Web 3D, some case studies

- As you can guess, publishing 3D contents on the Web may vary significantly depending on several factors:
  - 3D data (modeled, generated, acquired);
  - 3D contents (medical, entertainment, CH, artistic);
  - Publishing tool (oriented to: games, technical use, interaction, presentation);

- Particularly, the aim of the publishing can change a lot the type of publishing... Let’s see three selected showcase to understand more:
Jackson Pollock: Alchemy in 3D

- Three-dimensional diagnostic analysis of the painting 'Alchemy' by Jackson Pollock.
- Acquired a high-res 3D geometry of the painting (80M triangles), usable as metric and scientific documentation, to measure, study and analyze the materic structure of the painting.
- The resulting 3D models have been used to create an interactive kiosk and a physical reproduction of the painting for the museum exposition 'ALCHEMY BY JACKSON POLLOCK. Discovering the Artist at Work' (Peggy Guggenheim collection, Venice).
Jackson Pollock: Alchemy in 3D

- Link: [http://vcg.isti.cnr.it/alchemy](http://vcg.isti.cnr.it/alchemy)
The Neptune Fountain in Bologna

- Information system for the restoration of the Neptune Fountain.
- The system heavily uses the high-resolution 3D models of the fountain (600M triangles), as all the annotation, analyses and observations are mapped on the 3D surface of the structure.
- The system is completely online, and the restorers can access and work on the 3D models directly from the field.
The Neptune Fountain in Bologna

- Link: http://vcg.isti.cnr.it/activities/nettuno
The Edition-Topoi repository

- Efficiently integration of a large 3D collection in an online multimedia repository.
- The repository would contain a very heterogeneous dataset: 2000 ad over 3D models, acquired using different techniques (Laser scanning, Structure-Light scanning or Structure-from-Motion), resulting objects of different types (point clouds and meshes, with or without color and other attributes...) and size.
- The project consists in the implementation of a semi-automated pipeline to automatically wrap 3D data in different conditions.
The Edition-Topoi repository

- Link: http://repository.edition-topoi.org
Concluding

- Publishing 3D contents on the Web is an action possible nowadays, that in the near future will become even more accessible to all.

- It is important to stress that does not exist only one type of publication: you have to choose the way to convey your information, depending on several factors (3D data, 3D contents, publishing tool, target audience)...

- ... and the success of your publication will depend on these choices!
Thank you! Questions?

- **3DHOP – 3D Heritage Online Presenter:**
  - Web: [www.3dhop.net](http://www.3dhop.net)
  - Email: [info@3dhop.net](mailto:info@3dhop.net)

- **ARIADNE Visual Media Service:**
  - Web: [http://visual.ariadne-infrastructure.eu](http://visual.ariadne-infrastructure.eu)