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VR in VR: Capture and Display of Virtual Reality Photospheres in a Visual Resources Context

Abstract

At Michigan State, we have begun investigating some possibilities for creating and displaying photospheres in art history courses. Virtual reality-style presentation is particularly appealing for teaching architecture, archaeological sites, and other large, complex works that benefit from a spatial understanding that is otherwise difficult to communicate effectively when actual travel is not an option. Our pedagogical experiments are at a very early stage at this point, but the following report seeks to summarize and recommend various technical approaches to the tasks of creating and displaying virtual reality content in the context of visual resources.

Keywords

photospheres, Quicktime VR, spherical panoramas, virtual reality, Google Cardboard, photography, imaging

Author Bio & Acknowledgements

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An interior view from the Galleria Borghese in Rome, shot with a Ricoh Theta m15 in July 2015. View the interactive version on their website.¹

Photospheres

“Photosphere” or “photo sphere” are shorthand terms for photographic spherical panoramas, which are photos that cover a 360-degree horizontal field of view, and a 180-degree vertical field of view, such that they represent the complete interior surface of a hollow sphere when modeled in three-dimensional space. These types of photographs are traditionally captured by rotating a camera around a central point (the center of the sphere), to capture many overlapping views and then “stitching” all of the photos together to create a seamless view of everything surrounding the camera. With the proper software and/or hardware to display and interact with these images, it is then possible to create a simple virtual reality experience of the complete space in which the photo was captured.

Variations on the photosphere idea have been around for quite some time. For example, Apple began supporting this type of imagery in 1994 with the now semi-defunct Quicktime VR (QTVR) format. Artstor, in collaboration with Columbia University, has collected almost two thousand QTVR panoramas of world architecture within the last decade. I started making photospheres for both creative and professional purposes in 2007. However, for much of the last twenty years, photospheres have remained something of a niche interest, largely due to the high degree of difficulty and specialized equipment required to make them, and limited options for displaying them. In the last couple of years, these two barriers have come down in a big way, bringing the possibility of practical photosphere creation and viewing into the mass market consumer realm.

In light of these technological shifts, I have begun collaborating with faculty to investigate the possibilities of using this type of imagery in art history courses. Virtual reality-style presentation is particularly appealing for teaching architecture,

¹ <https://theta360.com/s/qBTolCp0Br1iWiP8t4FJnvHWK>

archaeological sites, and other large, complex works that benefit from a spatial understanding that is otherwise difficult to communicate effectively when actual travel is not an option. Our pedagogical experiments are at a very early stage at this point, but the following report seeks to summarize and recommend various technical approaches to the tasks of creating and displaying virtual reality content in the context of visual resources.

Capture

The old-fashioned method of capturing photospheres is still viable (and even preferable in some cases), though it can be time-consuming and requires some special equipment. A camera with a fisheye lens is preferable for this method because the extreme wide angle of the fisheye will reduce the total number of shots taken to achieve a complete sphere, but technically any camera with any lens would work. A tripod is also necessary, along with a panoramic tripod head.²

The panoramic tripod head allows the camera to be rotated around the optical center of its lens, eliminating parallax errors when stitching the images later. It also allows precise and repeatable measurements of camera position on two axes.

Photoshop does a fine job of stitching together a few images, but tends to fail on larger batches of images with wider angles, and cannot create a seamless spherical projection. The best option is to use a program that specializes in this type of work, such as PTGui.³

The details of creating spherical panoramas with a setup like this are too numerous to discuss here (there are many tutorials available on the web), but suffice to say it takes some practice and preparation, as well being a bit of a slow, clunky setup. The key advantage of using this method today is image quality. Images created this way have a resolution that is limited only by how many pictures are taken (more photos taken, at narrower angles of view = higher total pixel count in the final stitched panorama), and, therefore, best suited to spaces in which “zooming in” on fine detail is a priority.

Fortunately, the cost (and most of the complexity) of creating photospheres the old-fashioned way, can now be eliminated thanks to that 21st century Swiss Army knife known as the smartphone. The most recent version of the Google Street View app for Android and iOS devices can create spherical panoramas using only the built-in camera of a phone or tablet.⁴

The app uses on-screen guides for framing each shot to walk the user through the process. Once all the desired images have been captured (40 to create a complete sphere), the app automatically stitches them together. Photospheres can then be uploaded directly to Google Street View, and photospheres created by other users can be shared and viewed with full interactivity.

The ability to use a smartphone to easily create and view photospheres substantially opens up the possibilities for content generation and access, but there are also new tools purpose-built for the job, which provide further advantages. For example,

² <http://shop.nodalninja.com/nodal-ninja-3-1/>

³ <https://www.ptgui.com>

⁴ <http://google-latlong.blogspot.com/2015/09/introducing-new-street-view-app-from.html>

the “Theta”-series cameras made by Ricoh are very affordable, compact, quick, and easy to use. These cameras consist of two back-to-back fisheye lenses perched atop a handle with a shutter release button. Pressing the shutter button triggers exposures from both lenses simultaneously, and the two exposures are instantly and automatically stitched together by the camera to create a seamless photosphere in jpeg format. A wifi-tethered smartphone app allows manual and remote control of camera settings, as well as display and editing functions. The Theta cameras have the disadvantage of lower resolution than what is possible by shooting many individual exposures (whether with a smartphone or an SLR), however, the resolution is adequate for many scenarios (and is improving with each new model).⁵

Besides speed and ease of use, there are a couple of major advantages of the Theta cameras over other methods. For one, the fact that the two exposures are taken simultaneously means the camera is much better suited to any scene that includes moving subjects (otherwise people and other moving things tend to be cut up in multiple shots, and may create stitching errors or odd apparitions). Another advantage is that the camera can be used in very small spaces. Finally, and perhaps most importantly, the camera can capture spherical videos (mp4 format), with sound, for the full “virtual reality” experience.

Display

Once photosphere content has been created, there are a number of options for providing access. Because the typical output format is an ordinary jpg (or mp4, for video), there are no real limitations on the basic storage or distribution of photosphere content, so the question is more about display or playback in a way that will show the image with a correctly limited field of view, and with interactive features to enable zooming and panning. With the old Quicktime VR format, simply viewing content with the desktop Quicktime application or the Quicktime browser plugin was the main solution, though other flash-based, javascript, or HTML5 viewing platforms have also proliferated. More recently, Google Street View brought this functionality to Google Maps, and there are quite a few smartphone apps for viewing photosphere content, including the Ricoh Theta app (also available as a desktop version)⁶. For spherical videos, YouTube supports corrected, interactive playback in the desktop versions of Chrome and Firefox, as well as the YouTube app for Android.

There are other interesting possibilities for viewing photosphere content beyond the flat screen. In the last year or so, VR goggles or headsets have been enjoying substantial and increasing attention, leading up to the release of the Samsung Gear VR, and the much-hyped Oculus Rift. Headsets like these not only provide a more natural, field-of-vision-filling view but also detect movement, so that the user can “look around” within a scene, panning through photosphere content just by proportionate head movement, rather than clicking and dragging with a mouse cursor. Google designed an impressively low budget alternative, appropriately named “Cardboard,” which is simply a

⁵ <https://theta360.com/en/>

⁶ <https://theta360.com/en/support/download/>

stereoscopic viewer made out of a single piece of folded cardboard, with a space to hold a smartphone as the viewing screen.⁷

The Kiroru 360 app works quite well for viewing photospheres (both stills and video) with Google Cardboard, and in combination with a Ricoh Theta camera, makes for a very inexpensive and easy-to-use system for the quick capture and display of photosphere content.⁸

There are many other apps springing up designed for Cardboard and similar headsets, though most are oriented around specific and/or proprietary content streams, rather than simple playback of local content.

The VR headset viewing solution is very useful and compelling for individual use, however, it does have some drawbacks in a live, physical classroom. In a group setting, it can be a bit strange or isolating to use headsets, even if everyone has one because each person appears to be alone in the virtual space. For this reason, we have also looked into alternative projection-based display methods. On the simpler side of things, we set up a small classroom with four projectors (all connected to the same computer), one for each wall. In this case, no heroic efforts have been made to eliminate seams or corners between the four screens, so the effect does not create much of an illusion per se, but it is still effective as a way to show spatial relationships at a site or within a building.

Another option we have explored is the projection of photospheres in the planetarium on our campus. This can be a very compelling method, especially for large architectural interiors with notable ceilings. The illusion can be very good here, even when displaying non-round interiors on the dome-shaped ceiling, e.g. the Pantheon and the Sistine Chapel both look excellent. The planetarium is a less interesting option for exterior sites (since the bulk of the screen real estate is occupied by sky), or for interiors where the walls or floor are of main interest.

Next Steps

At this stage, we have essentially been figuring out the technical possibilities in trying to craft a pedagogical model that works well with photosphere content. We have thoroughly worked out the ability to capture content (and there is a rapidly growing selection of others' content available on the web), and we have mostly worked out the options for displaying content in the classroom. For the remainder of this academic year, the plan is for faculty to work on developing actual classroom activities and lectures using these methods. Beyond that, we hope to gather more content via faculty research travel and study abroad courses, in hopes of bringing more from these experiences back into the classroom.

⁷ <https://www.google.com/get/cardboard/get-cardboard/>

⁸ <https://itunes.apple.com/us/app/kiroru-360/id954157416?mt=8>