inside installations

What's the meaning of VR photography / VR panoramas?

A brief introduction to and overview of technical matters.

by Lutz Schmidt/art-documentation.com

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Co-author: Ulrike Baumgart
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art-documentation.com
Rheinweg 7
53113 Bonn
ls@art-documentation.com

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What is VR photography?

VR photography is the art of capturing a complete scene image as viewed when rotating about a single central position. Such a ‘panorama’ takes in the entire sphere around a spectator in a given space.

The acronym VR stands in this context for **V**irtual **R**eality.

There are currently three methods (documentation techniques) by means of which a 360 degree panorama can be photographed so that it can be represented in one individual image.

These methods are differentiated by their use of a range of photographic equipment: the choice of camera, the lenses and other optical devices that are employed, and the camera work itself. In all cases the camera is positioned on a tripod that comes to represent the viewer’s location.

The camera is usually located at eye level (spectators view).

Documentation technique 1: the recording of segments of the 360 degree panorama (segment technique).

Fig. 1

Required equipment: a ‘conventional’ camera, a wide angle lens and a panoramic tripod head.

Recording method: The surrounding space is photographed in segments. For these purposes the camera is mounted on a special panorama head that enables it to pan horizontally and vertically. These two panning axes must intersect at a particular point (usually within the lens) so that no parallax occurs when the camera is panned. This point is known as the ‘No Parallax Point’ (NPP). It is often also (incorrectly) referred to as the ‘nodalpoint’.

The recorded segments must overlap considerably at their edges so that a sufficient quantity of reference points exist on the relevant adjacent images when individual images are later combined together. Specialised software renders the individual images into one seamless VR panorama. This process occurs during image processing after the images have been captured. It is not integrated into the photographic process itself.

The resolution of the rendered VR panorama is determined by employing different lenses. If for example an extreme wide angle lens is used, the surrounding space can be recorded with a relatively low number of individual images and resolution is therefore relatively low. When employing a lens with a narrower angle, more individual images are required to photograph the entire 360 degree environment. Because each individual photograph theoretically contains the full resolution of the camera, the resulting VR panorama will consist of a considerably higher number of pixels (higher resolution).

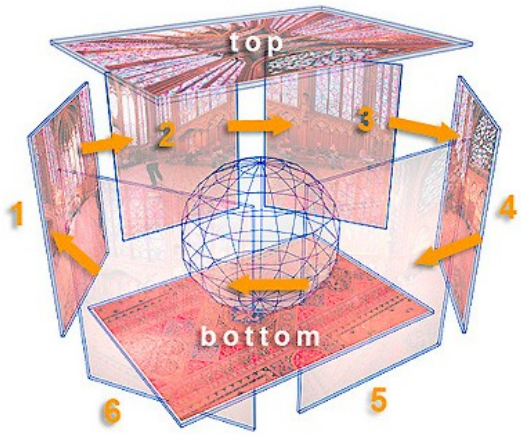

Fig. 2

The quality of the photographs and their resulting image is determined to a great degree by the various components involved in the process (camera, tripod, special panoramic tripod head). The more professional the equipment and the more individual components are calibrated so that they are compatible with one another, the more precise and authentic the result will be.

Documentation technique 2: photographing with the aid of a curved mirror.

Fig. 3

Required equipment: a 'conventional' camera and a special mirror angle scope.

Recording method: Instead of a conventional lens, a mirror scope is attached to the camera. The camera and mirror scope are aligned vertically. A special curved mirror in which the surrounding space is reflected is photographed (Christmas ball effect). The mirrors can be parabolic, hyperbolic or spherical. The resulting photograph (a round image in the form of a ring with a hole at its centre) is converted into a cylindrical 360 degree panaroma image with the help of specialised software.

A horizontal angle of 360 degrees can be captured, however the vertical angle is very limited (to a maximum of 115 degrees). A complete documentation of the space is only possible when a second photograph is taken with a camera that is horizontally aligned, and when both resulting photographs are 'rendered' with the help of specialised software.

The entire (non spherical) panorama is recorded in a single 'shot'. This makes the mirror method the fastest documentation method for achieving a VR panoramic image. In principle, any movements that happen within the space can be documented with ease.

The resolution is however extremely low, because it depends on the maximum resolution of the chip in the camera being used. It is not of sufficient quality to represent the details of a scene. One-Shot-Panoramas are only useful in order to gain an overview of a space.

Documentation technique 3: recording with the aid of a scanner camera

Fig. 4

Required equipment: a special camera on a tripod.

Recording method: The camera is attached to a vertical motorised axis and features a linear array sensor with a height of 5000-7500 pixels and a width of one pixel. During the photographic process the camera scans vertical lines pixel by pixel while rotating about the vertical axis. This method of recording is not suitable for 'freezing' motion, as the visual information is recorded over a duration of time. This disadvantage is barely apparent in ideal lighting conditions. In interiors however, lighting conditions are rarely ideal. In dark spaces this method of recording can last for several hours (!).

With this approach the panorama image is created in one 'take'. Unlike the other techniques, there is no postproduction required. The panoramic image is available immediately after the recording without further rendering.

There are very few companies producing this kind of camera. The best by far is the Spherocam.[1]

Two special features add to the advantages of recording VR panoramas with the Spherocam.

[1] http://tinyurl.com/25db4f

1) Distance measurement

It is possible to measure distances down to the centimetre with the aid of an image viewer that is supplied with the camera. The two end points of a distance to be measured are marked and the exact distance is able to be immediately determined. In order to make use of this feature, two panoramic images are taken from the same vantage point, but at different tripod heights (a difference in height of 50 cm between the two images is the basis for the measurement). Distance is calculated from the difference between both images. This is achieved by means of the classical principle of triangulation[2].

2) **H**igh **D**ynamic **R**ange Images

The camera's sensor is able to register extreme differences in lighting conditions. For example, it is possible to clearly register the filament of a glowing halogen bulb without losing the contours and details of the darker parts of the image. There are no problems with burn out and overexposure. This is not possible with any other camera currently on the market.

These unique features are reflected in the camera's price. It costs around 50.000 euros. A version without HDR and distance measurement functionality is available for half this price.

What is a spherical VR panorama?

A spherical VR Panorama is a fully immersive digital image where you 'the viewer' are placed in the centre of a sphere onto which a 360 degree wrap-around image is projected. The horizontal axis is 360 degrees and the vertical axis is 180 degrees.

In order to depict the entire representation of a 3D sphere on a single 2D image, it needs to be 'unfolded'. This can be achieved with the aid of different projection methods. This is similar to what happens when the globe of the earth (3D) is represented on a map of the world (2D). The only difference lies in the fact that in one case the sphere is observed from outside (globe), in the other however, it is represented from within (VR panorama).

An equirectangular projection[3] is usually used for 2D presentations of VR panoramas. The image below depicts this kind of representation of a VR panorama (spherical image of the space) showing an installation by Peter Bogers[4] (Fig. 5). The aspect ratio of such a projection is 2:1, because it represents a horizontal area of 360 degrees and a vertical area of 180 degrees.

Fig. 5

2 http://tinyurl.com/kruon
3 http://tinyurl.com/yrgjyz
4 Peter Bogers, "Heaven", 1995, video installation.
Exhibition: Play–Rev.–Play, Württembergischer Kunstverein, Nov. 2006 – Jan. 2007.

A VR panorama is an excellent format for the documentation of site-specific installations.
Because a viewer can only ever see one section of the entire image for analysis at one time, it quickly becomes clear that the ‘useful resolution’ of each individual section decreases considerably. In order to not only to have an overview of the space, but view smaller sections with (details) with a suitably sharp resolution, it is best to aim for a very high resolution with regard to the entire image. ‘Very high’ in this context means a value of at least 50 megapixels (5000 pixels high x 10000 pixels wide). An example illustrates the necessity for very high resolution:

Fig. 6

The image size of the photograph of Peter Bogers’ installation *Heaven* (Fig. 5) is 6000 x 12000 pixels (72 megapixels). The section marked in the image only covers a very small area of the entire documentation. If this section is printed in photorealistic quality[5], the size of the ‘print’ is only 6.6 cm x 9.6 cm[6].
Figure 6 shows the same section in its original size (300 dpi print resolution).

These values are based on common standards and definitions used to print photographs with a print quality comparable to that of images that have been chemically developed as prints from a photographic negative. In this process a particularly fine print resolution is employed. In practice however, a satisfying result can be achieved with considerably lower print resolution. The reverse of this implies that sections from panoramic images can be printed at a much larger scale than the example discussed here.
Figure 7 shows a detail from a screenshot of a VR panorama viewer.

Fig. 6

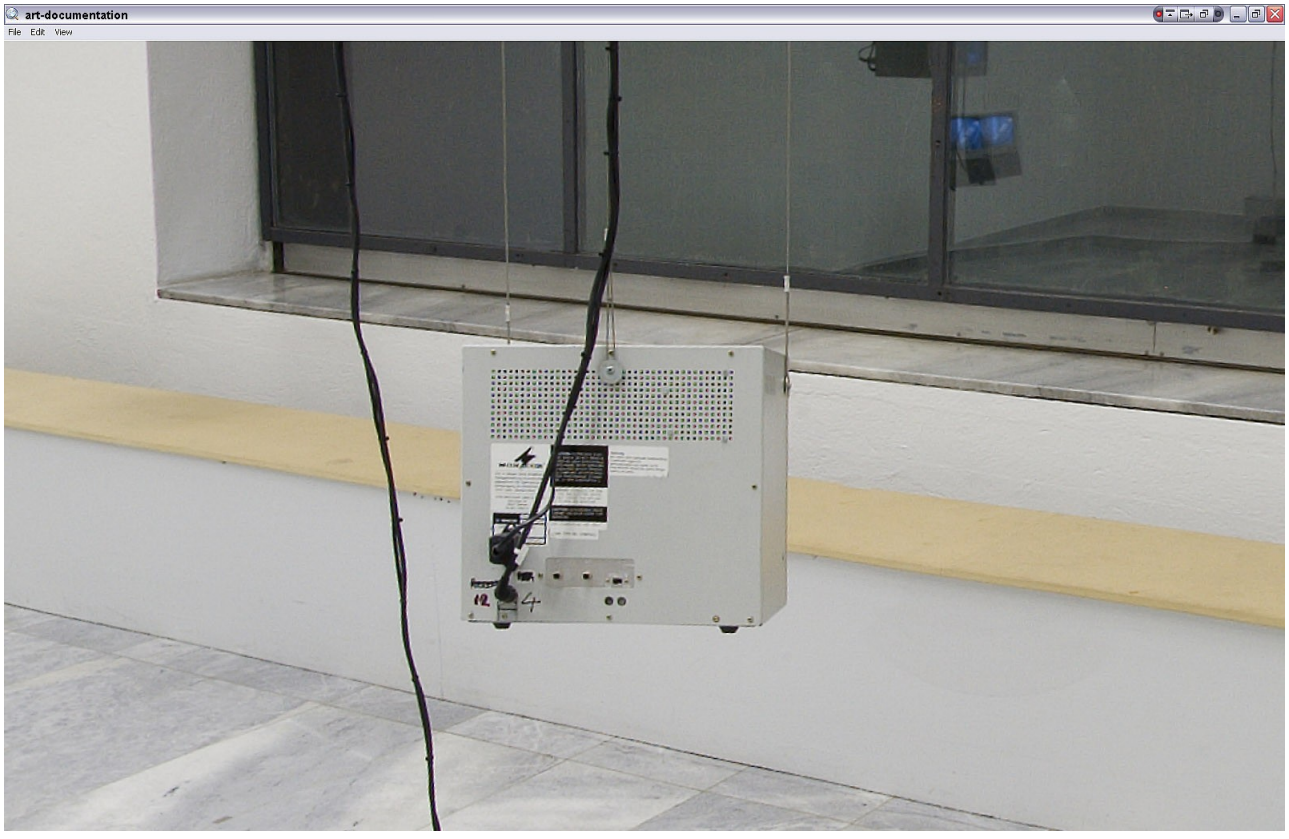

Fig. 7

[5] An output resolution of 300 dpi is the standard for photorealistic prints.
[6] The section marked in the VR panorama shows an area with ca. 23 horizontal degrees (of 360 degrees) and 33 vertical degrees (of 180 degrees). The resulting image size is 777 x 1131 pixels (0.88 megapixels).