Spherical Panoramas

Peter Gawthrop ARPS discusses using cameras with conventional perspective, together with panoramic tripod heads and software, to create spherical panoramas.

The development of perspective was one of the triumphs of Renaissance art; while the renunciation of perspective was a hallmark of 20th century art. However, perhaps because cameras make it so easy, perspective has not been a central concern of photography.

A disadvantage of conventional perspective is that it is restricted to quite narrow fields of view. In his book, *That’s The Way I See It*, David Hockney presents photo collages which challenge conventional perspective and give large fields of view. In particular, the seminal *Pearblossom Hwy* is, in his words, ‘… a panoramic assault on Renaissance one-point perspective’. More recently, Michael Hallett FRPS has pursued the collage approach – see, for example, page 218 of *Portfolio One*.

The use of panorama software meanwhile, whereby individual photographs can be stitched and blended to produce a seamless composite panoramic image, provides an alternative to collage.

**Projection**

The problem of representing a spherical panorama on a flat surface is the same as that of creating maps to represent the surface of the earth, and it is not surprising that many names and concepts have been transposed from one discipline to the other. In particular, the idea of projection is much used in discussion of spherical panoramas. Any projection from a sphere to a flat surface must lead to some distortion.

**Equirectangular projection**

The standard representation of the spherical panorama on a flat surface is the equirectangular projection, as in Figure 1. Above. As indicated by the superimposed grid, the feature of this projection is that lines of latitude and longitude are straight and equally spaced. This is not particularly visually pleasing, although the top and bottom could be cropped to give a conventional panorama. The importance of this projection is that it contains all of the pixels of the original spherical panorama, and is thus a good starting point for more interesting projections.

Although special panoramic cameras are available, most photographers don’t own one. You can instead create an equirectangular panorama using a conventional digital camera, equipped with a special tripod mount, together with software. The key is to take photographs in enough directions to cover the imaginary sphere.

**PRACTICAL CONSIDERATIONS**

**Field of view**

The field of view of the lens in use determines how much of the sphere is covered by each shot; a large field of view implies fewer shots are needed, but will result in fewer pixels for the construction of the panorama. A full frame camera such as the Canon
EOS 5DII or a Nikon D700, with a 15mm full frame fisheye lens, is a good choice which, when used in portrait orientation, gives about 100° horizontally and 150° vertically. With careful choice of shooting directions, eight shots should suffice to create an equirectangular panorama of around 10000x5000 pixels.

**Parallax**

Look though your viewfinder and swing round: you will find that vertical objects move relative to one another. This is called parallax, and must be avoided when shooting panoramas. Panoramic tripod heads, which avoid this effect by swinging the camera about the lens nodal point, are essential for good quality results.

**Bracketing**

As each picture is to be joined together, it is simplest (though not essential) if they are all taken using the same (manual) exposure. The problem is that a good setting in one direction may not work in another.

When spherical panoramas include features in direct sunlight and shadow as well as sky, it is not possible to get a satisfactory exposure to cover the sphere on a single exposure setting. In this circumstance, I use auto exposure bracketing to give me three exposures: shooting at normal, one stop over, and one stop under, in each shooting direction, resulting in a total of 24 exposures. This gives a satisfactory range when the three exposures are combined.

To keep things organised, it helps to create a new folder on the memory card for each set of 24 images.

**Shooting spherical panoramas: step by step**

1. Choose a location for the tripod. Consider: artistic merit; firm footing for the tripod; safety - you must be able to walk around the tripod while concentrating on the camera; hiding the sun - ie the camera is in shadow.
2. Fix the panoramic head and the camera. Make sure the camera plate is exactly located to the tape marks.
3. Attach the remote switch to the camera.
4. Level the camera. I use a Ball camera leveller.
5. Set lens to manual focus, and focus it to infinity.
6. Set the camera pointing up at 30° to the horizontal. Set the horizontal position at about zero and pointing towards the central feature of your panorama.
7. Use the remote to take the three bracketed exposures, and rotate the camera though 90° horizontally.
8. Repeat to give three further sets of pictures.
9. Set the camera pointing down at 30° to the horizontal. Repeat steps 7 and 8.
10. Set the horizontal position back by 45°. Repeat steps 7 and 8.
Right: Fig 5. Wide angle projection. This has about 300° of view around the horizon. Note how the edges are enlarged compared to the centre, giving the feeling of the small church lost in the large landscape. www.lightspacewater.net

Processing
The basic idea is to stitch three panoramas from eight photographs - one for each exposure level. I prefer to choose my own control points. I use what I call ‘cross-stitching’: each top row photo has control points to the two adjacent photos in the bottom row. The three panoramas are then combined in Gimp to take advantage of the full exposure range.

Software
Software is key to processing these 24 images into a single panorama. Gimp (www.gimp.org) and Hugin (hugin.sf.net) are open source software which can be used to stitch panoramas. Open source software has the advantages that anyone can contribute to its development, and that it is available free of charge.

Hugin takes the 24 images and aligns, stitches and exposure-blends them into a spherical panorama in
equirectangular form, which can be Tiff, Jpeg, or even high dynamic range format.

This spherical panorama can then be converted to a format suitable for interactive panoramic viewers, such as Quicktime or Flash. The alternative is to warp perspective in such a way as to project the panorama onto a flat image. This gives unlimited potential to convert the panorama, on a spectrum from the realistic to the totally abstract.

Figs 2–5 show projections which are all generated from the equirectangular panorama of Fig 1. There are many projections available in Hugin. I find the Lambert and Stereographic the most useful. Fig 2 is the Lambert projection, while Figs 3, 4 and 5 are Stereographic.

Conventional perspective appears to give the view from a rectangular window. Panoramic photography removes this constraint, creating a range of visual possibilities.

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