Panoramas and Perspective

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The development of perspective was one of the triumphs of Renaissance art; and the renunciation of perspective has been the 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. David Hockney, in his book “That’s the way I see it”, has interesting photo-collages which challenge conventional perspective and give large fields of view. In particular, Hockney’s seminal “Pearblossom Hwy” photo-collage 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”.

Digital photography, together with corresponding software, gives us an alternative to collage whereby individual photographs can be stitched and blended to give a seamless composite panoramic image. This article explores the visual possibilities released by discarding conventional perspective in this way.
The starting point is the so-called *spherical panorama* which can be explained as follows. Imagine standing at a viewpoint on a fine day and looking all around the horizon, up to the point above your head and down to your feet – you are viewing a spherical panorama. The word “spherical” comes from imagining that you are surrounded by a transparent sphere centred on you head; the scene then seems to be painted onto this sphere – the spherical panorama.

If this transparent sphere is imagined as the earth with lines of longitude (numbered from $180^\circ W$ – $180^\circ E$ with $0^\circ$ straight ahead) and latitude (numbered as $0^\circ$ at the equator, $90^\circ N$ at the north pole and $90^\circ S$ at the south pole) then every point that we see can (like places on the earth) be assigned a unique latitude and longitude. The problem of representing a spherical panorama on a flat surface is the same problem as that of creating maps to represent the surface of the earth and it is not surprising that many names and concepts have been taken from one problem to the other. In particular, the idea of a *projection*, for example Mercator’s projection, is much used. It is clear that any projection from a sphere to a flat surface must lead to some distortion.

[Figure 1 about here.]

The standard representation of the spherical panorama on a flat surface is the *equirectangular* projection. An example taken down by the Spey at Kincraig is given in Fig. [1]. 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 a particularly visually pleasing projection, 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 have one. Instead, one can use a conventional digital camera equipped with a special tripod mount together with some special software to create an equirectangular panorama. The key idea is to take photographs in enough directions to cover the imaginary sphere which are then processed back home in the computer. But there are a number of practical considerations to be considered first, the most important of which are camera field of view, parallax and exposure.

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

Look through 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. Special panoramic heads are available which avoid this effect by swinging the camera about the lens nodal point; they are essential for good quality results.

As each picture is to be joined together, it is simplest (though not actually 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. The solution is to
use exposure bracketing (±2 stops) in each direction. This procedure results in a total of 24 exposures. To keep things organised it helps to create a new folder on the flashcard for each set of 24 images.

Software is key to processing these 24 images into a single panorama. Many photographers rely on commercial products for digital processing and are unaware that there is an active community dedicated to developing open-source software for photographers. The GIMP (GNU image manipulation program – www.gimp.org ) is perhaps the most widely-used software in this context. Open source software has the advantage that anyone can contribute to its development; it is also available free of charge. Thanks to a dedicated group of enthusiasts, the panoramic software package “hugin” is available for download for use on Linux, Apple and Microsoft platforms. Hugin takes the 24 images and aligns, stitches and exposure-blends them into a spherical panorama in equirectangular form which can be either be in a conventional TIF or JPEG format or even a high dynamic range format. A manual and tutorials are available from the hugin website at hugin.sf.net.

This spherical panorama can be converted to a format suitable for an interactive panoramic viewer such as Quicktime or Flash. But the alternative is to warp perspective in such a way as to “project” the panorama onto a flat image; this gives the photographer an unlimited artistic potential to convert the panorama into images on a spectrum from the realistic to the abstract. Hugin contains a range of projections together with an interactive controls and display giving instant feedback to the photographer.
Figures 2–6 show some projections which are all generated from the equirectangular panorama of Figure 1. There are many projections available in Hugin; I find the “Lambert” and “Stereographic” the most useful. Within these two projections there are many possibilities some of which I have named according to how they strike me. In particular, Fig. 2 is the “Lambert” projection and looks like a glass paperweight; Figs. 3, 4, 5 and 6 are all “Stereographic” projections and look, I think, like the names I have given them.

Conventional perspective, as used in conventional photographs, appears to give the view from a rectangular window. The unconventional perspective described in this article removes this constraint and opens up new visual possibilities to be exploited by photographers.
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Figure 1: Equirectangular projection. This is the basic projection of the spherical panorama onto a flat surface. The lines of latitude are marked in yellow and the lines of longitude in green. The top and bottom correspond to the north and south poles of the sphere and are thus elongated. On the other hand, parts near to the middle (corresponding to the equator) are not distorted. The left hand and right hand edges correspond to 180°W and 180°E respectively and thus show the same location. The small white church at the upper right of the picture, shaded by the Scots Pine, appears in many of the following images.
Figure 2: Paper-weight projection. The “Lambert” projection gives a circular image with the illusion of a glass sphere containing the image.
Figure 3: Tunnel projection. This projection gives the feeling of being inside the scene and being aware of objects all around at the same time. For example, the tree at the top of the picture is the pine shading the church behind the viewer and would be seen like this if the viewer looked upwards.
Figure 4: Wide-angle projection. This has about $300^\circ$ 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.
Figure 5: Planet projection. Planet pictures are becoming a cliché. Nevertheless, this projection gives a dramatic image in this case. There must be a clear view of the sky for this to work.
Figure 6: Hole projection. This is an example of an abstract image created from the landscape. The sky appears though a hole in the water hence the name