Nomadic Perspectives:
Spatial representation in oriental scroll painting and holographic panoramagrams.

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Abstract : Experiments in composition and effects of holographic panoramagrams (computer generated holography), demonstrate an analogy between this three-dimensional imaging process and Oriental horizontal scroll painting. These two ways of representing space share a similar conception of spatial representation in which multiple points of view are spread horizontally, parallel to the scene. The similarities are not only geometrical and conceptual, they also reveal a direction in the development of new spatial representation technologies in which the observer isn't only a passive receiver of visual information from a fixed position, but an active observer. This paper is based on analysis of the holograms structure as well as on artistic experiments in composition and art history researches.

For centuries, artists and scientists have tried to represent space in a way that the image conveys the illusion of dimensions and distances. Perspectivists have relied on several geometrical methods to project space appearances on a flat surface. These methods are essentially egocentric: in panoramic perspective for example, the artist is placed in the center of the world, representing the environment surrounding him by rotating his unique point of view from a fix location. As for binocular perspective, or stereoscopy, it is barely entering the world of spatial imaging by adding a second point of view that gives a sensation of distance between objects. Viewing apparatus and limited number of points of view may have prevented stereoscopy and autostereoscopy to expand its field of applications. As for holography, sensibility to vibrations, technical complexity and limitations of subject matter has prevented it from becoming an accessible 3D imaging technique. Thus, spatial imaging is still in need for a practical freeviewing[1] 3D representation method. While most imaging systems inherit their geometrical and optical characteristics from the occidental perspective tradition, some of them, like computer generated holographic

[1] Freeviewing : in 3D imaging, freeviewing is the ability to view three-dimensional images and perceive artificial 3D without using a viewing device like prism glasses, polarized filters, goggles, etc.

panoramagrams[2], draw up a link with oriental representation of space as seen in horizontal scroll painting. Its hybrid conception of spatial representation offer new possibilities in spatial imaging as well as in the presentation of visual information, and gives to the observer the liberty to choose its point of view and interact naturally with the 3D space.

1. Multiple points of view perspective:

In the computer generated holographic process I use, a three-dimensional scene is created in a 3D graphic software, in which the space is defined by the standard *(x, y, z)* coordinates, *"x"* being the horizontal axis, *"y"* is the vertical axis and *"z"* is depth. A virtual camera moves laterally, on the *"x"* axis, in front of this 3D scene recording a large number of conical perspective images corresponding to a series of juxtaposed points of view. These images provide us with the necessary viewing angles to recreate horizontal parallax perception. This set of images is used to expose a holographic film using a holographic imager developed recently in Montreal (Canada) by XYZ Imaging inc.. This machine is an automated printer in which a pulsed RGB laser and an optical system produce small overlapped holographic pixels on large format high resolution emulsions. When the resulted hologram is displayed and lighted by a point source white light, it reconstructs the full colour three-dimensional appearances of the represented space. When observers move laterally in front of the hologram, they perceive successively and stereoscopically the juxtaposed points of view, consequently, the spatiality of the scene and its volumetric content. Since the hologram is made of a large number of images that will be viewed over time with the observer's movements, short animations can be added to the scene. Therefore, holographic panoramagram are not only three-dimensional, but also dynamic in interaction with the viewer's positions and movements.

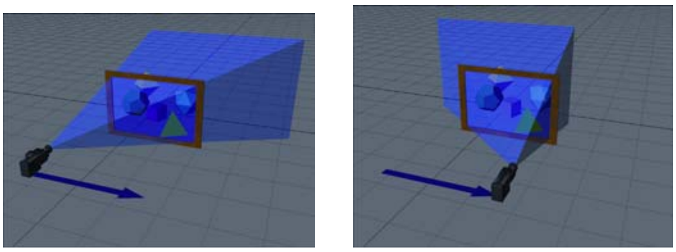

Fig. 1 & 2: Virtual camera setup of a computer generated holographic panoramagram.

[2] Holographic panoramagram are often called "holographic stereogram". The term "panoramagram" should be employed since they allow continuous parallax viewing. OKOSHI, Takanori, Three-Dimensional Imaging Techniques, Academic Press, NewYork, 1976, p. 247.

It is interesting to note that, from antiquity up to the development of a coherent perspective system during the renaissance, attempts in perspective representation were constructed from many points of view but, lacking a unified geometrical composition approach, these experiments resulted in incoherent spatial representation. In the history of perspective systems, while the viewer's eye is considered unique and immobile in Alberti's and Piero Della Francesca's[3] approaches, the recognition of the dynamic and multiplicity of points of view as a requirement for coherent perspective representation of space was present in northern European renaissance[4]. However, experiments in this field became mostly optical curiosity and didn't survive the utilitarian applications that directed perspective development since the XVIth century.

We tend to see the invention of the stereoscope in the XIXth century[5] as the beginning of multiple points of view imaging. In fact, the first stereoscopic drawing is attributed to Giovanni Battista Della Porta around 1600. Unfortunately, to be viewed correctly, stereoscopic images need a special optical display apparatus. Without it freeviewing is difficult and uncomfortable, if not impossible, and most of the time the result is double images, obvious distortions or headaches. As for autostereoscopy or lenticular imaging, while they offer stereoscopy without viewing devices, the limited number of points of view prevents this approach to be able to provide continuous parallax and volume realism. As you may have noticed, these 3D images tend to flatten volumes as if objects were cut-out images with distances between them. Autostereoscopy is, by definition, a multiple points of view perspective system but it is, by far, unable to provide the quality of 3D visual information available in holographic panoramagrams.

Since the invention of holography by Denis Gabor[6] in 1948, several important developments have transformed this diffraction based imaging process. One of which is the multiplex hologram developed by Lloyd Cross[7] in 1972. Computer generated holographic panoramagrams are a variation on the composite approach of the multiplex hologram principle. Instead of using film or video images, the source images are computer generated and the compositing of a full 3D hologram is made by exposing a large number of small holographic pixels. This method allows much more possibilities in contents and visual effects.

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[3] BRION-GUERRY, L., *Jean Pélerin Viator – sa place dans l'histoire de la perspective*, Société d'Édition les Belles Lettres, Paris, 1962, p.46

[4] Idem, pp.79-81

[5] Mirror stereoscope: Charles Wheatstone, 1838. Prism Stereoscope: David Brewster, 1849.

[6] Denis Gabor (1900-1979), Nobel prize 1971.

[7] Lloyd Cross. In 1972, he used cinematographic images to expose a holographic emulsion resulting in animated images. These multiplex holograms are also called "holographic stereograms".

What the holographic panoramagram technology offers, is a coherent multiple points of view perspective system. In this 3D imaging process, geometrical parameters of the 3D scene are determined by the optical characteristics of the imaging system and the size of the hologram. The format of the hologram (height and width), in relation to the pixel size (0.8mm or 1.6mm), will determine the camera field-of-view, its distance from the hologram plane and the image resolution to render. It will also determine the number and point of view positions for the juxtaposed images to render. These parameters are used to circumscribe the three-dimensional scene constructed in the 3D graphic program. What we obtain with this approach, is a multiple perspective images that are combined in an optical viewing device, the hologram itself, to reconstruct the appearances of continuous parallax, as if we were observing a real wide field of view three-dimensional space.

The landscape hologram (fig. 8) for example, is 380mm X 1200mm, the holographic pixels size is 0.8mm, the virtual camera in the 3D software was at a distance 2494mm from the hologram plane and it moves laterally on a distance of 1600mm, each side of the center of the x axis. This virtual camera registered a set of juxtaposed images at a resolution of 5501 X 475 pixels. With these parameters, the resulting hologram presents a spatial structure that resembles a double truncated pyramid jointed by its small base delimited by the hologram plane. 3D objects appear behind and in front of the hologram plane, in full volume, and a large panoramic view of the scene is offered to the observer, thanks to the 1280 juxtaposed points of view.

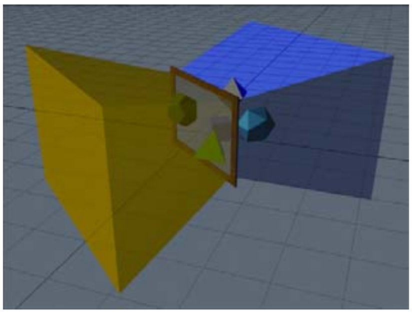

Fig. 3: Spatial structure of a computer generated holographic panoramagram.

2. Spatio-temporal observation of holographic panoramagrams:

My first experiment in spatio-temporal composition of holographic panoramagrams included content closely related with time. It was a simulation of the 1999 total eclipse over Europe (fig. 4). It presented one hour of the astronomical phenomenon, showing the moving shadow on earth synchronised with a clock showing the time, the appearance of a few cities when the eclipse was total over them, the position of the sun and a view through a telescope of the eclipse with its flash.

When the observer moves from left to right, the event is viewed chronologically. In this experimental hologram, the hour is only a reference since the observer can view the whole event in a few seconds. If he moves from right to left, the eclipse is reversed. Content is presented on the basis of synchronisation of information instead of a linear presentation over time.

Fig. 4: « Simulation of the 1999 total eclipse over Europe »; Jacques Desbiens, 2004,

Experiments like this have shown that some spatial features of the holographic panoramagram have a strong influence on composition choices and on perceptual effects. Spatial contradictions can occur: *"time-smear"* are distortions or blurring caused by animation speed and patterns can create *"moiré"* effects. One feature makes this imaging approach very particular: time distortions can be caused by viewing conditions. For example: *"Simultaneity"* occurs when two observers see different points of view and therefore two different moments at the same time. *"Reversibility"* in which an animated scene created to be viewed from left to right will be seen in reverse if an observer moves from right to left, as described in the eclipse hologram experiment. *"Speed incoherence"* is also an important effect on compositional characteristics: it doesn't matter if a represented movement is slow or fast, continuous or jerky, speed appearance will depend on the movement of the viewer. Observers can move fast or slow, go back and forth or they can stop whenever they want. Consequently, holographic panoramagrams are non-cinematographic, space is given, time is given up.

3. Points of view shifting as nomadic perspective:

These spatio-temporal characteristics make the holographic panoramagram a distinct media, with its own spatial structure, its own relationship with time, its own way to convey information. By experiencing the impact of technological features on the composition of holographic images, it became clear to me that this 3D media posses conceptual similarities with ancient spatial representation approaches that tries to include multiple points of view perspective and observer's movement.

In the composition of a 3D scene for a holographic panoramagram, the virtual camera is setup to render a set of individual images corresponding to each point of view needed to reconstruct horizontal parallax. Each of these images are conical perspective views of the scene, but the virtual camera gradually shift its position on the x axis transforming this traditional occidental perspective into a multiple points of view system of spatial representation. Even though we use the term “panoramagram”, this camera movement isn’t a “panoramic rotation”, but a “travelling”. The observer, as the camera, moves in space.

This viewing movement, this continuous point of view shifting as a mean of spatial representation is central to the holographic panoramagram process, and it is rarely found in occidental art and imaging history. On the other hand, in oriental history of spatial representation, the multiple points of view approach is widespread. In Chinese landscape scroll painting, the space is represented as a series of points of view from which the artists depicted objects, lakes and streams, trees, houses, hills, mountains and clouds, while travelling in the landscape. Scroll paintings may not produce the optical illusion of distance and three-dimensionality, but as in the holographic panoramagram, space is visualized dynamically through many points of view.

Fig. 5: Kuo Hsi, “Clearing Autumn Skies Over Mountains and Valleys”, 11th century.

These long scrolls link the representation of space to the representation of time which are transferred to the viewing experience itself. As in the holographic panoramagram, control over viewing time of a long landscape scroll painting isn’t available. Forms, brush strokes, hue, intensity, spatial organisation is constructed, composed. Time, speed and direction are left to the observer’s choices.

This analogy between holographic and scroll painting dynamics became apparent through experimentation. While I was composing a 3D scene for a hologram, I made experimental drawings in concertina format Chinese sketchbooks. These very long drawings (fig. 6) represented imaginary landscapes viewed from a series of juxtaposed points of view. I also made, the same way, several long format computer generated landscapes (fig. 7). The influence of format on composition, the impact of point of view shifting and movement as a way to conceive space, transformed my conception of 3D composition for computer generated hologram.

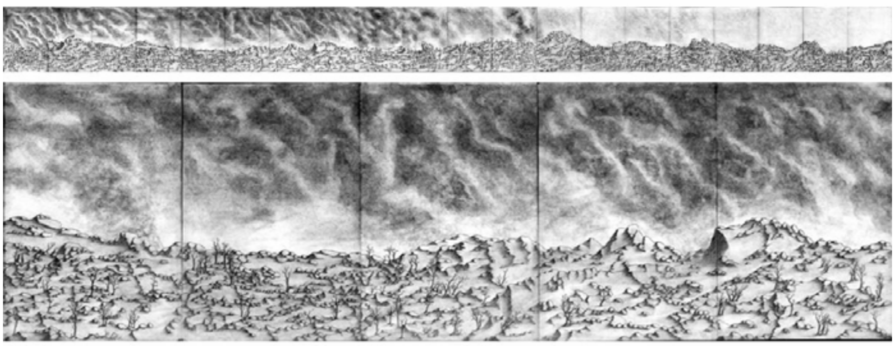

Fig. 6: “Landscape”, Jacques Desbiens, 2005, graphite on paper,
concertina sketchbook & detail, 337cm X 25cm,.

Fig. 7: “Computer generated landscape”, Jacques Desbiens, 2004.

The holographic panoramagram “The broken window” (fig. 8) is the latest in this series of experiments in representing space through the observer’s movement. This hologram represents a scroll unrolling when the observer move from right to left. The 3D image depicted is a window through which we can see a deep landscape. The glass in the left pane is broken by a tree branch that appears in front of the hologram plane.

From all those experiments, it became clear to me that multiple point of view imaging is a distinct approach to perspective in which movement through space is the principal mean of depicting our own relationship with the spatial structure. It is travelling, it is nomadic perspective.

Fig. 8: “The Broken Window”, Jacques Desbiens, 2006.
Central point of view of the source images for a holographic panoramagram, 120cm X 38cm.

4. Three holographic zones:

When working on composition of 3D scenes for holography, one becomes very aware of the importance of the geometrical structure of space, the positions of objects in relation with the hologram plane, but also of the role of void between objects. Distances, overlapping, occlusion, juxtaposition, objects movements, become more than esthetical components, they are tools in shaping space, in creating the illusion of volumes and presence. A branch shadow will convince the observer that the object is in front of another and occlusion of some objects by others will reinforce the appearance of depth. “In front” and “behind” are concepts spread in the whole set of points of views.

Holographic space can be divided in three zones (see fig. 3): the foreground in which objects appear in front of the hologram plane, this is a real image as defined in optics terminology; then there is the hologram plane itself which is a flat surface position on the emulsion; and finally there is the background in which the objects appear behind the hologram plane, this is the virtual image. When composing a hologram, these three holographic zones are very similar to the "three distances" (san yuan) as described by Kuo Hsi in his XIst century painting treatise "Lofty Messages of Forests and Springs" (Lin ch'üan kao chih)[8].

Kuo Hsi's three distances concepts, "high distance" (gaoyuan), "deep distance" (shenyuan) and "level distance" (pingyuan), are obviously different from the holographic foreground, hologram plane and background zones, and it is surely different from occidental perspective constructions. Nevertheless, by introducing a distance relationship between content and appearances, these concepts find their application in the composition of a hologram scene by analogy to the positioning of objects in the holographic space and the effects of depth of field. Indeed, the sharpness of an object in the virtual holographic space will decline with distance, as in most oriental landscape painting, the background is blurry. On the other hand, the visual quality of objects appearing in front of the hologram plane, as a real image, can be affected by convergence when they are too far from the hologram plane. So distances of objects, in relation to the holographic zones, are related to sharpness and visibility. But moreover, the three distances concepts help us understand the process of, not only positioning objects in relation to each other, but also of composing space itself in relation to multiple and dynamic points of view. The role of fog, void, contrast and superposition in shaping volume and distance between object in oriental painting is similar to positioning objects in the empty illusionary space of holograms. Luminance and chromaticity, emptiness and occlusion, play important parts in the visibility of spatial relationships.

When the composition represent a non-geometric subject, like a landscape, these composition elements are critical to an efficient perception of three-dimensional space. And again, multiple points of view and the observer's movement are the main components in providing this spatial illusion. A real or an imaginary landscape invites the viewer to wander, to change points of views, to move. However, our tradition of flat imagery, observed from a unique point of view, made us accustomed to representation and observation in inertia, through a fix window. Often, when I show one of my holograms to people who never seen computer generated holographic panoramagrams before; they position themselves toward the center of the hologram and stay there. I have to tell them to move, to change points of view. We can understand that it is rare to find spatial representations asking for observation in movement thus, the proliferation of such spatial imaging technologies may change our physical relationship with the image. The creation of such images will have to consider our movement, in natural or artificial environments, as part of the representation.

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[8] Kuo Hsi (XIst century), _Lofty Messages of Forests and Springs_ (Lin ch'üan kao chih), published as _An Essay on Landscape Painting_; translated by Shio SAKANISHI, John Murray, London, 1935.

5. Narration through multiple points of view perspective:

There is some example of geometrical perspective associated with multiple points of view in long scroll format. However, these are not conical perspective but rather parallel perspective constructions[9] which allowed the artist to maintain apparent coherence while shifting points of view and moving through the scene. Apparently, this technique facilitated the introduction of narrative content. While we can find a few example of narrative content depicted in very long horizontal composition in occidental art, they are either a chronological depiction of events without any spatial representation of three-dimensionality, like the Bayeux tapestry[10], or a fix representation of space and time as in most cylindrical panoramas[11].

Fig, 9: Zhang Zeduan, "Upper River during Qing Ming Festival", XIIth century.
Detail of parallel perspective in a long scroll painting.

Chinese scroll painting however, presents a wide representation of space and time with a multiple points of view spread in real space, as well as many examples of narrations of either chronological or parallel subjects. This way of presenting content in space and time, link with the movement of the artists and, by extension, of the observer, make oriental scroll painting and holographic panoramagrams related in their approaches of presenting narrative content. In both cases, the observer can view the content by shifting its point of view and by synchronising the different elements for each sequence. Linearity may be suitable, but again, it is left to the observer's choices.

In computer generated holographic panoramagrams, visual information is spread out through its multiple points of view spatial structure. Synchronisation of content in space becomes the dominant way of conveying information. Instead of

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[9] WELLS, Wilfrid H., *Perspective in early Chinese painting*, Edward Goldston ltd., London, 1935.

[10] The Bayeux tapestry is a 70m by 50cm embroidered cloth depicting the 1066 battle of Hastings. The images are describing chronologically the events leading to the conquest of England by the Normans.

[11] Many painted panoramas were created in Europe during the XVIIIth and XIXth centuries. These images were painted inside a large cylindrical room usually depicting war scenes, cityscapes and historical events.

having the content given in a flowing linear and chronological manner as in cinema, the observer has to participate in finding the links between the different elements of content. His movements and choices of angles of viewing allow him to reconstruct the message. This characteristic makes holographic panoramagram a very different method of presenting visual information and narration. This is different from fix 2D images, kinetic media like cinema or video, interactive media like the internet, or even traditional optical holography. It is also very different from 3D imaging systems like virtual reality because the observer's movements are real and interactivity is limited to direct freeviewing.

It is quite extraordinary that one of the oldest forms of spatial representation, oriental scroll painting, is analog to one of the most recent technological advancement in spatial imaging. These structural and conceptual analogies emphasise the fact that, by merging oriental and occidental conception of spatial representation, we are moving into nomadic perspectives. With new interactive imaging technologies, beyond stereoscopy, the observer's movements may be the requirements for an efficient illusionist spatial representation. These new technologies of three-dimensional imaging may change, not only the way we represent space with geometry and optics, but also our very conception of spatial representation and our role in its dynamics. Chinese scroll paintings and holographic panoramagrams may be very different in visual effects, in structure and in techniques; nevertheless, they share a similar conception of spatial representation. The fixity of traditional perspective is evacuated. The artist and the observer are not in the center of the world anymore, they are passing through the environment. These similarities show us new ways of representing the space we share and the artistic and scientific heritage on which we build our future.

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