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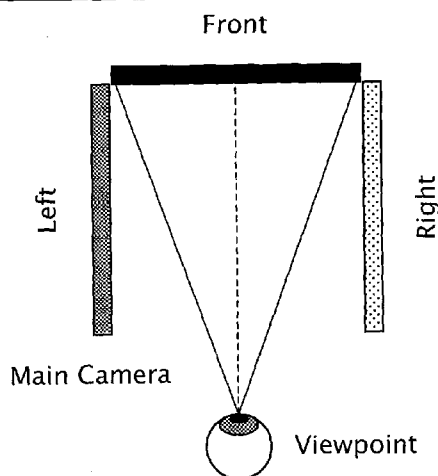
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(54) Title: THREE DIMENSIONAL IMAGING SYSTEM

FIG. 2

2D Image Mapped to a 3D Planar Surface



(57) Abstract: A display system comprising first and second panels, where the second panel is maintained at a different orientation with respect to the first panel such that the first panel is non-coplanar with the second panel. The display system projecting the image onto the first and second display panels in such a manner so as to reduce geometric distortions of a viewer when viewing the image.

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DESCRIPTION

TITLE OF INVENTION:

THREE DIMENSIONAL IMAGING SYSTEM

TECHNICAL FIELD

5 The present invention relates generally to a system for rendering an image on multiple non-planar displays.

BACKGROUND ART

10 There is a large amount of two-dimensional and three-dimensional content available suitable for display on multiple monitors. In many cases, displaying the content across multiple monitors provides a desirable viewing experience. For example, a desktop computer may be interconnected to a plurality of monitors, with the image being displayed across
15 the multiple monitors. In some cases, the displays may be arranged in a semi-circular arrangement so that the image content provides a more encompassing experience in front of the viewer. Unfortunately, depending on the image content, the resulting viewing experience is less than desirable
20 because the image lacks a natural perspective view.

 The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the

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invention, taken in conjunction with the accompanying drawings.

SUMMARY OF INVENTION

5 The invention provides a display system comprising: a first panel; a second panel maintained at a different orientation with respect to said first panel such that said first panel is non-coplanar with said second panel; said display system projecting a image onto said first and second display
10 panels in such a manner so as to reduce geometric distortions of a viewer when viewing said image.

 The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the
15 invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

 FIG. 1 illustrates a multi-pane display system.

20 FIG. 2 illustrates an embodiment of a 2D image mapped to 3D planar surfaces.

 FIG. 3 illustrates an embodiment of a 2D image mapped to a 3D cylindrical surface.

 FIG. 4 illustrates an embodiment of a 2D image mapped
25 to a 3D spherical surface.

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FIG. 5 illustrates an embodiment of a 2D image mapped to 3D planar and cylindrical surfaces.

FIG. 6 illustrates multiple depth layers mapped onto surfaces.

5 FIG. 7 illustrates a technique for single-viewpoint rendering of 2D images on multiple panels.

FIG. 8 illustrates an embodiment of single viewpoint rendering of 3D scenes.

10 FIG. 9 illustrates a technique for single-viewpoint rendering of 3D scene on non-planar panels.

FIG. 10 illustrates a top view of a display camera configuration.

FIG. 11 illustrates a frontal view of a display camera configuration.

15 FIG. 12 illustrates a generalized technique for perspective projection.

FIG. 13 illustrates identified corners of a panel.

FIG. 14 illustrates determined vectors of a panel.

FIG. 15 illustrates on-axis projection.

20 FIG. 16 illustrates off-axis projection.

FIG. 17 illustrates frustum extents.

FIG. 18 illustrates vectors from the eye position to the screen corners.

25 FIG. 19 illustrates an embodiment of a multiple viewpoint rendering of 3D scenes.

FIG. 20 illustrates graphically single and multiple viewpoint rendering.

FIG. 21 illustrates rendering with an enlarged zone of projection.

5 FIG. 22 illustrates a technique for multiple viewpoint rendering of a 3D scene on non-planar panels.

FIG. 23 illustrates a technique using multiple virtual cameras for multiple viewpoint rendering.

10 FIG. 24 illustrates a technique using multiple virtual cameras to generate images for multiple panels.

FIG. 25 illustrates an adjustment of 3D scene rendering for multiple virtual cameras.

DESCRIPTION OF EMBODIMENTS

15 Referring to FIG. 1, a tiled display system includes a plurality of flat display panels. Each of the flat display panels are preferably arranged in a non-planar orientation where the flat display panels are maintained in a fixed orientation with respect to one another. The angular
20 relationships between the panels are preferably maintained in a known relationship with respect to one another. In addition, the system preferably includes a calibration screen that permits the identification of the properties of each panel, and their orientation with respect to one another. The plurality of
25 panels results in a display system that is larger than an

individual panel, and also permits the orientation of the panels to be arranged to provide more three dimensional realism. Based upon the location of the viewer, the geometric configuration of the panels may result in different geometric distortions. In addition, the different orientations of the panels results in different geometric distortions, even for the same location of the viewer. Accordingly, the display system should preferably modify the two-dimensional and/or three dimensional image content in a suitable manner for presentation on the plurality of flat panel displays in a manner that reduces the geometric distortion. In many situations, there are multiple viewers viewing the same content from different locations. In such situations with multiple viewers, it is desirable to modify the two-dimensional and/or three dimensional content in a suitable manner for presentation on the plurality of flat panel displays that reduces the geometric distortion for each, while not as optimal for each.

Referring to FIG. 2, the rendering of a two dimensional image on a plurality of panels may be based upon the viewer's viewpoint with respect to the panels. Referring to FIG. 3, the two dimensional image may be mapped onto a cylindrical surface. Referring to FIG. 4, the two dimensional image may be mapped onto a spherical surface. Referring to FIG. 5, the two dimensional image may be mapped onto a combination of

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planar surface and a cylindrical surface. Referring to FIG. 6, the two dimensional image may be converted to form a plurality of two dimensional images each of which having a different "depth". The different depth layers may be manually
5 labeled by the viewer and/or determined using automatic image segmentation techniques. The different two dimensional depth images may be mapped to a surface, such as that illustrated in FIG. 2, FIG. 3, FIG.4, FIG. 5 and/or FIG. 6.

10 FIG. 7 illustrates a suitable technique for rendering two-dimensional images on a plurality of panels for a single viewer at a single viewpoint (or an estimated viewpoint) serving as a center of projection (COP). For each pixel on a panel, a ray may be extended from the COP, through the two-dimensional
15 pixel, until the ray intersects with the virtual three dimensional surface. The color and/or luminance of the intersection point on the surface is sampled and assigned to the two-dimensional pixel. The process may thus be a sequential combination of inverse-projection and perspective
20 projections. This process may be repeated for all of the panels of the display system.

Referring to FIG. 8, multiple three dimensional objects may be located virtually behind the panels, which may be arranged in any suitable arrangement. The rendering
25 technique may be suitable to reduce the distortion of the

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objects rendered on the panels at a COP, even though the combination of panels are not planar.

FIG. 9 illustrates a suitable technique for rendering three dimensional images on a plurality of panels for a single viewer at a single viewpoint serving as a center of projection. Perspective projection parameters may be computed for each panel based on their geometric configuration. The viewpoint for each panel may be located at the same location, namely the center of projection. To render the three dimensional scenes with more suitable geometry for each of the panels, a virtual camera for each panel may be used to project the three dimensional scene onto the panel with perspective projection, one for each display. The optical center of each camera may be located at the same position as the eye position. The optical axis of each camera may be perpendicular to the plane of its corresponding display. The view looking down on this configuration from above is illustrated in FIG. 10, and the frontal view of this display camera confirmation is illustrated in FIG. 11. This process may be repeated for all of the panels of the display system.

Given the width of the display, the height of the display, the original three dimensional coordinate system, the eye position, then the three dimensional coordinates of the corners of each panel may be determined. Otherwise the three dimensional coordinates of the corners of each panel

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may be provided. With the corners of each panel determined or otherwise provided, the eye position, the near and far projection planes, a perspective projection matrix may be computed. With the three dimensional scene and the perspective projection parameters, a three dimensional perspective projection technique may be used to determine two dimensional images for the panels which are projections of the three dimensional scene from the specified viewpoint.

Referring again to FIG. 11, for purposes of illustration and without loss of generality, the display system may include, one left display, one central display, and one right display. The angle between the left/right display and the central display may be denoted by θ , where θ is ≥ 90 degrees. To display a single coherent virtual environment, all of the display may define their projections in a common coordinate system. The coordinate system may be defined as follows. Define the origin at the center of the central display. The XY-plane may be aligned with the central display, the X axis points to the right, the Y-axis points to the top, and the positive Z-axis points to the viewer. The positions of the corners of the panels may be defined, such as being measured, determined, and/or provided. The eye position may be located at $(0, 0, Z_{eye})$ where Z_{eye} ensures that the eye can see all the displays.

The user may move within the space and is not required

to remain centered upon any of the screens. Because the display wraps around the user, at least in part, the screens may not lie in the XY plane. Referring to FIG. 12, a more generalized perspective projection is illustrated.

5 The standard perspective projection may be determined separately for each screen-eye pair (or each eye). By way of example, referring to the left panel of FIG. 11, the perspective projection may be determined based upon an assumption that the eye is looking perpendicular to the display. This frustum
10 is then rotated afterwards such that the screen is non-perpendicular to the viewing direction.

Referring to FIG. 13, the panel characteristics include screen corners p_a at the lower left, p_b at the lower right, and p_c at the upper left. These values are used to encode the size
15 of the screen, its aspect ratio, its position, and/or its orientation. Referring to FIG. 14, these locations may be used to determinate an orthonormal basis for the screen space. In screen space, the system may refer to these basis vectors as v_r , the vector toward the right, v_u , the vector
20 pointing up, and v_n , the vector normal to the screen (pointing directly out of it).

As the standard axes x , y , and z define an orthonormal basis for describing points relative to the origin of 3D Cartesian space, the screen-local axes v_r , v_u , and v_n define a
25 basis for describing points relative to the screen. These

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screen-local axes may be computed as follows:

$$v_r = \frac{p_b - p_a}{\|p_b - p_a\|} \quad v_u = \frac{p_c - p_a}{\|p_c - p_a\|} \quad v_n = \frac{v_r \times v_u}{\|v_r \times v_u\|}$$

There are two primary types of perspective projection, namely, on-axis projection and off-axis projection.

5 Referring to FIG. 15, the on-axis projection may include an eye p_e centered on the screen. The line from the eye drawn perpendicular to the screen along v_n strikes the screen directly in the middle. One may refer that point of intersection as the *screen-space origin*. This coincides with
10 the origin of the screen-space vector basis depicted above. Also in this configuration, the pyramid-shaped viewing frustum having the screen as its base and the eye as its apex is perfectly symmetric.

Referring to FIG. 16, the off-axis projection where the
15 eye position is moved away from the center of the panel, results in the frustum being no longer symmetric, and the line from the eye drawn along v_n no longer strikes the panel in the middle. Thus, when the viewer moves the screen-space origin moves with him. A projections may be based upon, the
20 left frustum extent, the right frustum extent, the bottom frustum extent, the top frustum extent, and distances to the near and far clipping planes. These values may be referred to as l , r , b , t , n , and f respectively. The first four frustum values may be understood as distances from the screen-space

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origin to the respective edges of the screen, as shown in FIG. 17. As illustrated in FIG. 17, l and b are negative numbers, while r and t are positive numbers, in this embodiment. If the user moves far to the side of the screen, then the screen space origin may not fall within the screen at all, and any of these variables may be positive or negative.

The frustum extents are computed for use in computing the perspective projection. One technique for computing the frustum extents based upon screen corner positions and eye position. Referring to FIG. 18 as an intermediate step, the system may first compute vectors from the eye position p_e to the screen corners. These vectors may be computed as follows.

$$v_a = p_a - p_e \quad v_b = p_b - p_e \quad v_c = p_c - p_e$$

In particular, let d be the distance from the eye position p_e to the screen-space origin. This is also the length of the shortest path from the eye to the plane of the screen. The system computes this value by taking the dot product of the screen normal v_n with any of the screen vectors. Because these vectors point in opposite directions, the value may be negated, namely $d = -(v_n \cdot v_a)$.

Given this, frustum extents may be computed. Take the frustum right extent r for example. When one takes the dot product of the *unit* vector v_r (which points from the screen origin toward the right) with the *non-unit* vector v_b (which

points from the eye to the right-most point on the screen) the result is a scalar value indicating how far to the right of the screen origin the right-most point on the screen is.

Because frustum extents are specified at the near plane, it is desirable to scale this distance back from its value at the screen, d units away, to its value at the near clipping plane, n units away:

$$l = (v_r \cdot v_a)n/d$$

$$r = (v_r \cdot v_b)n/d$$

$$b = (v_u \cdot v_a)n/d$$

$$t = (v_u \cdot v_c)n/d$$

These values may be used in a 3D perspective projection matrix, defined as follows:

$$P = \begin{bmatrix} \frac{2n}{r-l} & 0 & \frac{r+l}{r-l} & 0 \\ 0 & \frac{2n}{t-b} & \frac{t+b}{t-b} & 0 \\ 0 & 0 & \frac{f+n}{f-n} & -\frac{2fn}{f-n} \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

Note that the near and far clipping plane distance, n and f , may be specified based on the distances from the eye position not origin.

As defined above, the result is a frustum for an arbitrary screen viewed by an arbitrary eye, while the base of that frustum lies in the XY plane. Some graphical projection techniques only work when the view position is at the origin, looking down the negative Z axis, with the view plane aligned

with the XY plane. To facilitate use of such a graphical project technique and/or use a different graphical projection technique, two additional determinations may be made, such as, first rotating the screen to align with the XY plane, and
 5 second correctly positioning it relative to the user.

The rotation of the screen to align with the XY plane may be performed by defining a 4×4 linear transformation matrix M using the screen space basis vectors v_r , v_u , and v_n as columns:

$$M = \begin{bmatrix} v_{rx} & v_{ux} & v_{nx} & 0 \\ v_{ry} & v_{uy} & v_{ny} & 0 \\ v_{rz} & v_{uz} & v_{nz} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

This is a transformation matrix for screen-local coordinates. It maps the Cartesian coordinate system onto the screen space coordinate system, transforming the standard axes x , y , and z into the basis vectors v_r , v_u , and v_n .
 15 If something is lying in the XY plane, then this transformation matrix M will realign it to lie in the plane of the screen.

However, this is the opposite of what is often desirable. It is preferable to have something lying in the plane of the screen realigned to lie in the XY plane, so that the system
 20 may apply a perspective projection to it. Hence instead it is preferable to have the following mapping:

$$M = \begin{bmatrix} v_{rx} & v_{ry} & v_{rz} & 0 \\ v_{ix} & v_{iy} & v_{iz} & 0 \\ v_{nx} & v_{ny} & v_{nz} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Then one multiplies the perspective projection matrix P by this M to rotate the frustum to align with XY plane. Now the system has a perspective projection which relaxes the projection plane alignment.

So far the obtained perspective projection is still referenced to the origin. Next the frustum may be modified to position the apex at the eye-position. This may be achieved by translating the eye position to the apex of the frustum. The apex of the perspective frustum is at zero, hence it may be translated along the vector from the eye. This can be accomplished by applying a transformation matrix, such as for example:

$$T = \begin{bmatrix} 1 & 0 & 0 & -p_{ex} \\ 0 & 1 & 0 & -p_{ey} \\ 0 & 0 & 1 & -p_{ez} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

These three matrices may be composed into a single projection matrix, $P' = PMT$.

Beginning with constant screen corners p_a , p_b , p_c , eye position p_e (varying by eye-tracking), and near and far clipping plane distances, a projection matrix is suitable for flexible configurations. An arbitrary number of arbitrarily-oriented screens may be defined together in a common

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coordinate system, and the resulting projection matrices present these disjointed screens as a single, coherent view in a virtual environment.

Referring to FIG. 19, multiple three dimensional objects may be located virtually behind the panels, which may be arranged in any suitable arrangement. The rendering technique reduces the distortion of the objects rendered on the panels at a COP, even though the combination of panels are not planar. In addition, the rendering technique may be modified in a suitable manner to accommodate multiple simultaneous viewpoints by rendering images toward multiple centers of projection. The resulting images, while not typically as good as they would appear to a single viewer at a single viewpoint, will be visually acceptable with otherwise reduced distortion. FIG. 20 illustrates graphically the resulting visual experience by using a multiple viewpoint rendering technique. The single-viewpoint rendering algorithm has limitations. The viewers can see distortion-free image only at one optimal spot A in the 3D space and will see lower-quality images anywhere else B. However we generate multiple sub-optimal spots C at a larger viewing zone. This is more practical for multiple viewers.

Referring to FIG. 21, the result of the multiple viewpoint rendering technique may be an enlarged suitable viewing zone. Thus, the each panel (e.g., the entire panel)

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may be rendered to multiple viewpoints. The resulting renderings are combined in some manner to determine the values for each of the pixels of each of the displays.

Referring to FIG. 22, a technique for multiple viewpoint rendering of a three dimensional scene for non-planar panels is illustrated with multiple enlarged COPs. The first, third, and fifth steps may be performed in a manner similar to the two dimensional image embodiments, if desired. The number of virtual cameras and their positions may be computed based on the number of viewers and their positions, or otherwise selected in any manner. In one embodiment, one virtual camera may be defined for each viewer and each panel. For example, if there are two viewers, two virtual cameras are defined for the front panel as illustrated in FIG. 23. The two cameras cover different parts of the three dimensional scene and have overlapping portions. The two dimensional image on the front panel may be generated by applying perspective projection towards these two virtual cameras, respectively. Thus, the entire image may be divided into multiple sub-images, where each panel is sub-divided into a plurality of regions, which are then adjusted based upon the viewer's positions. For example, the virtual camera #1 may correspond to the right half of the front panel, while the virtual camera #2 may correspond to the left half of the front panel. In this manner, the angled observation of the display

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for a viewer is rendered in a more accurate manner for the respective viewer. As illustrated in FIG. 24, two virtual cameras may also be defined for portions of the left panel and portions of the right panel, resulting in a total of six virtual cameras. The entire images on the three panels are then generated based upon these six cameras separately, with overlapping areas.

As multiple virtual cameras are used to render images on the same panel, there may be conflicts between the sub-images, especially along the border region between them. This is due to the fact that the sub-images are rendered based upon different center of projections and the visual perception is affected by their difference. Step four and six tend to reduce this conflict. At step four, the three dimensional objects in the scene may be slightly adjusted such that they do not lie in the overlapped regions of the two cameras. This can effectively reduce the conflicts between the virtual cameras. FIG. 25 illustrates an example of re-organizing the three dimensional scene to reduce the conflict zone (as indicated by the dotted circle).

Step six applies post processing to the generated two dimensional images in order to reduce and smooth out the conflicts between different views. In one embodiment, a blending technique may be applied to mix the two adjacent images together and form a smoother and more uniform view

of the three dimensional scene. In particular , the image blending step may also use the three dimensional geometry to increase the correctness of the rendered shapes, e.g., straight lines and circles with correct aspect ratios.

5 Another embodiment of step six is to use multiple virtual cameras to generate the entire images from different viewpoints and apply an image warping technique to generate intermediate views. The image warping step may be implemented by decomposing the image into multiple
10 triangular regions and then warping each triangle into an intermediate location, similar to an image morphing technique. This warping step may reduce the conflicts between the overlapped regions and generate a new view with smooth shape variations across the whole image. The warped image
15 may have some degree of geometric distortion. The distortion, however, is reduced by the image warping process.

 In many situations for rendering, it is sufficient to specify the field of view such as the near and far clipping plane distances, together with an implicit assumption that
20 the viewer is directly in front of the display, facing perpendicular to the display, and looking in the center of the display to achieve sufficient rendering. However, often such specifications are inappropriate for a non-planar set of panels.

 To reduce such limitations, it is desirable to permit a
25 generalized perspective projection. A generalized perspective

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projection permits the viewing direction to be non-perpendicular to the projection plane, permits the viewing point on the display to be at any point in the screen instead of being restricted to the center, and/or permits the projection frustum to be rooted at any point. With the 3D coordinates of the corners of the projection screen, the 3D coordinates of the eye position, and the near and far clipping plane distances, then generalized perspective projection may be computed more efficiently. One manner of efficient computation is first computing the perspective frustum assuming the eye is looking perpendicularly to the screen, then rotating the viewing frustum such that something lying in the plane of the screen is realigned to lie in the XY plane; and next positioning the frustum relative to the user by moving the viewing frustum from origin to the eye position. The perspective frustum may be computed from the frustum extents (top, bottom, left and right) which are further computed given the coordinates of the corners of the screen.

In many cases, a perspective projection technique may be suitable for rendering the images. In other cases, such as extreme wide displays, it may be more desirable to incorporate a non-perspective projection technique as applied to a single viewpoint, multiple viewpoint and/or split display techniques.

The terms and expressions which have been employed in

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the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

CLAIMS

1. A display system comprising:

(a) a first panel;

5 (b) a second panel maintained at a different orientation with respect to said first panel such that said first panel is non-coplanar with said second panel;

(c) said display system projecting a image onto said first and second display panels in such a manner so as to
10 reduce geometric distortions of a viewer when viewing said image.

2. The display system of claim 1 wherein said first panel is a flat panel.

15 3. The display system of claim 2 wherein said second panel is a flat panel.

20 4. The display system of claim 3 wherein said first panel and said second panel are at an angle greater than or equal to ninety degrees with respect to one another.

5. The display system of claim 4 wherein said image is a two-dimensional image.

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6. The display system of claim 4 wherein said image is a three-dimensional image.

7. The display system of claim 6 wherein said three-dimensional image is modified prior to said projecting.

8. The display system of claim 1 wherein said projection is based upon a viewpoint at the center for each panel.

9. The display system of claim 1 wherein said projection is based upon a separate projection for each panel.

10. The display system of claim 1 wherein said projection is based upon a viewpoint not at the center for each panel.

11. The display system of claim 1 wherein said projection is based upon a plurality of projections for each panel.

12. The display system of claim 11 wherein each of said projections is based upon a different viewpoint.

13. The display system of claim 5 wherein a plurality of

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depths are defined of said two-dimensional image.

14. The display system of claim 1 wherein said projections use a common coordinate system.

5

15. The display system of claim 14 wherein said projection based upon the viewer looking perpendicular to respective ones of said panel.

10 16. The display system of claim 15 wherein said projection is based upon a frustum rotation.

15 17. The display system of claim 16 wherein said frustum rotation results in a non-perpendicular viewing direction.

18. The display system of claim 16 wherein said projection is based upon an on-axis projection.

20 19. The display system of claim 16 wherein said projection is based upon an off-axis projection.

20. The display system of claim 16 wherein said frustum is non-symmetric.

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21. The display system of claim 1 wherein said projection of claim 1 is based upon a plurality of spaced apart viewpoints.

5 22. The display system of claim 21 wherein said projections are based upon a plurality of projections for each panel.

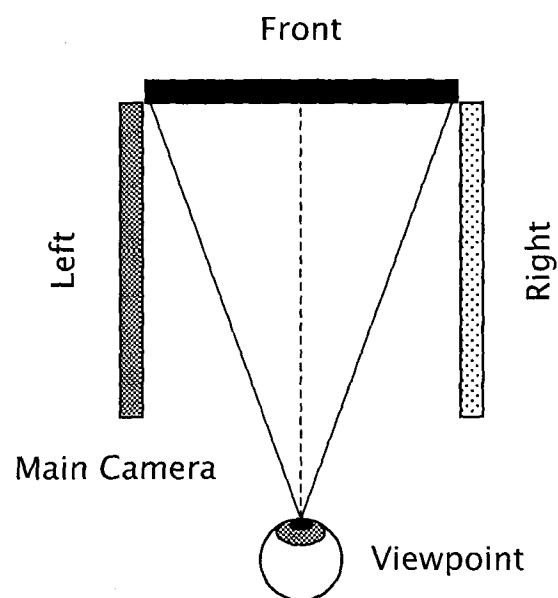
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FIG. 1



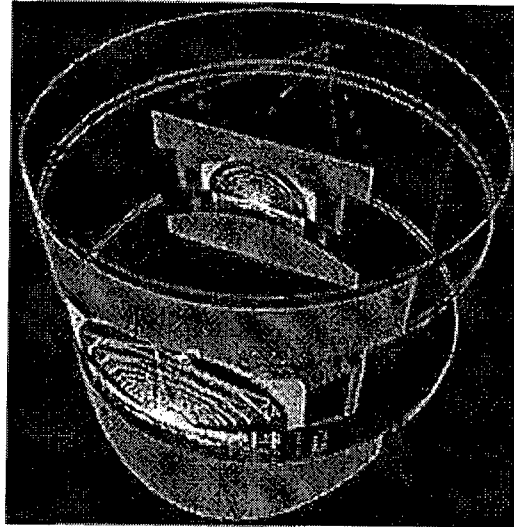
FIG. 2

2D Image Mapped to a 3D Planar Surface



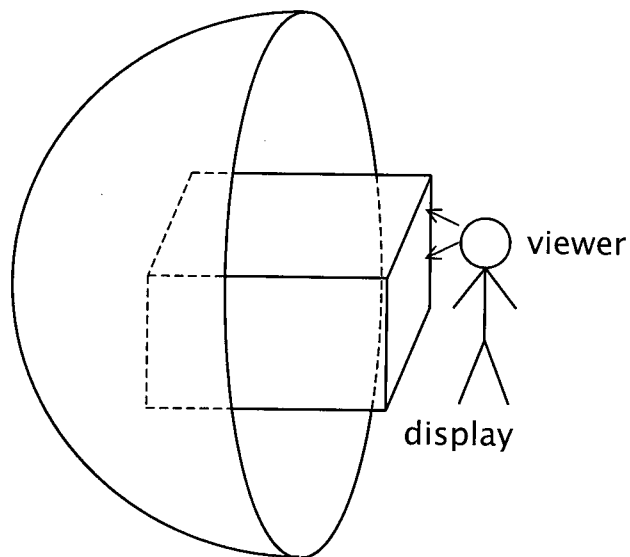
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FIG. 3



Cylindrical surface

FIG. 4



Virtual surface

Spherical surface

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FIG. 5

2D Image Mapped onto a Cylindrical Surface

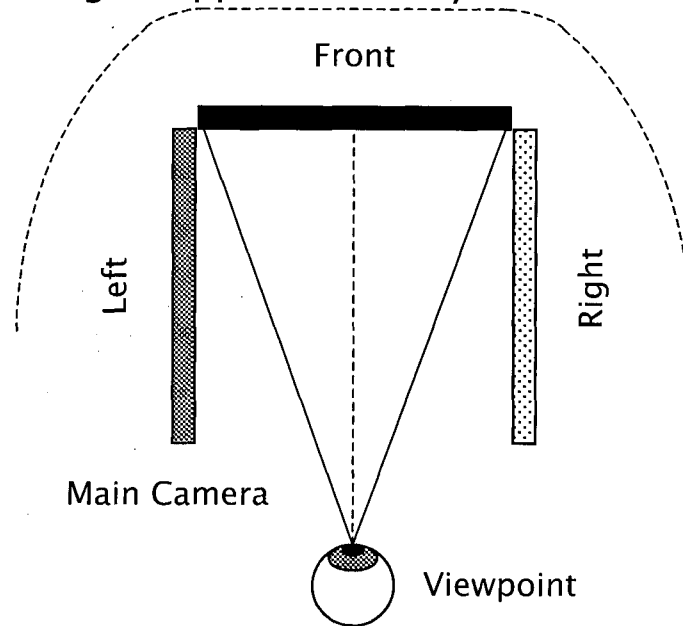
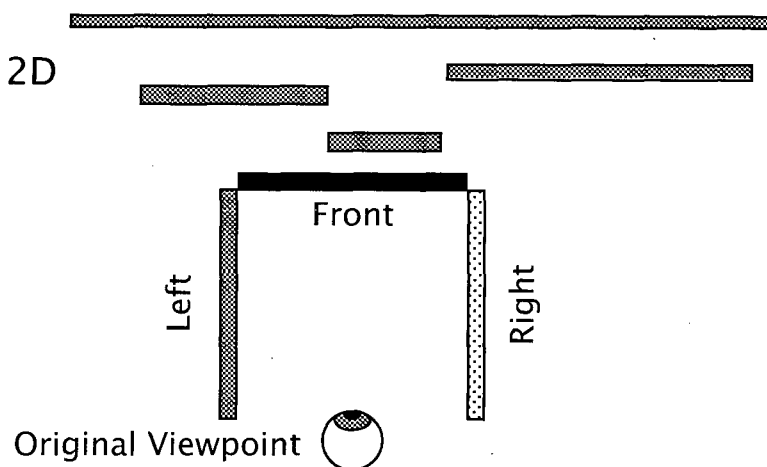


FIG. 6

Depth layers
converted from 2D
images

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FIG. 7

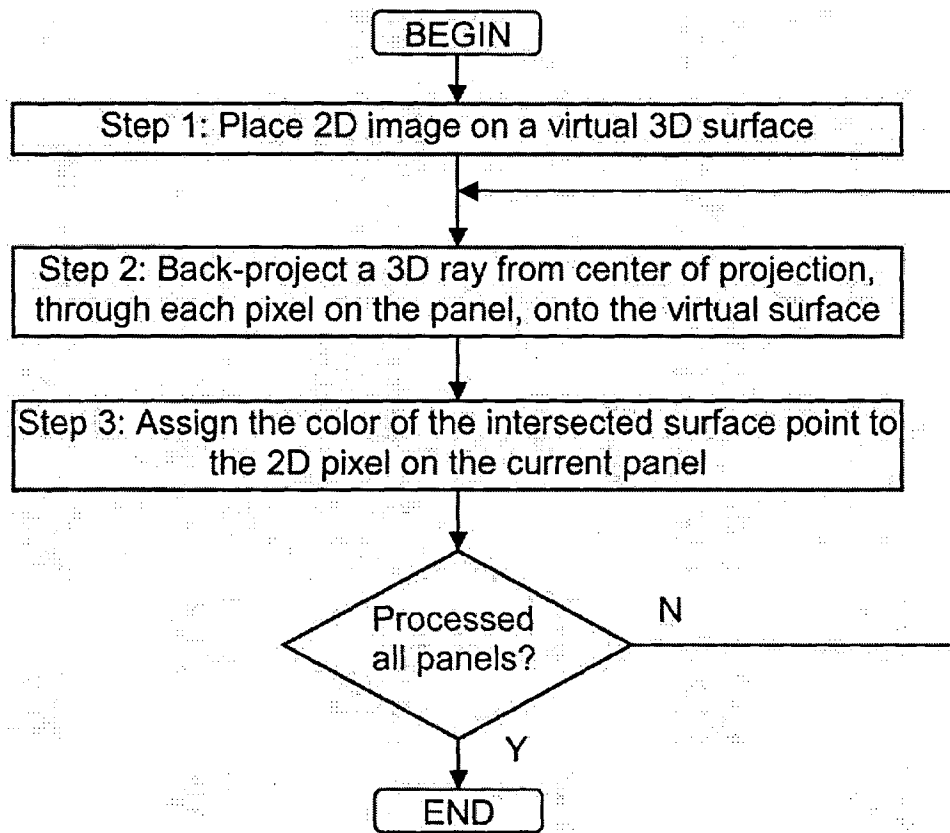
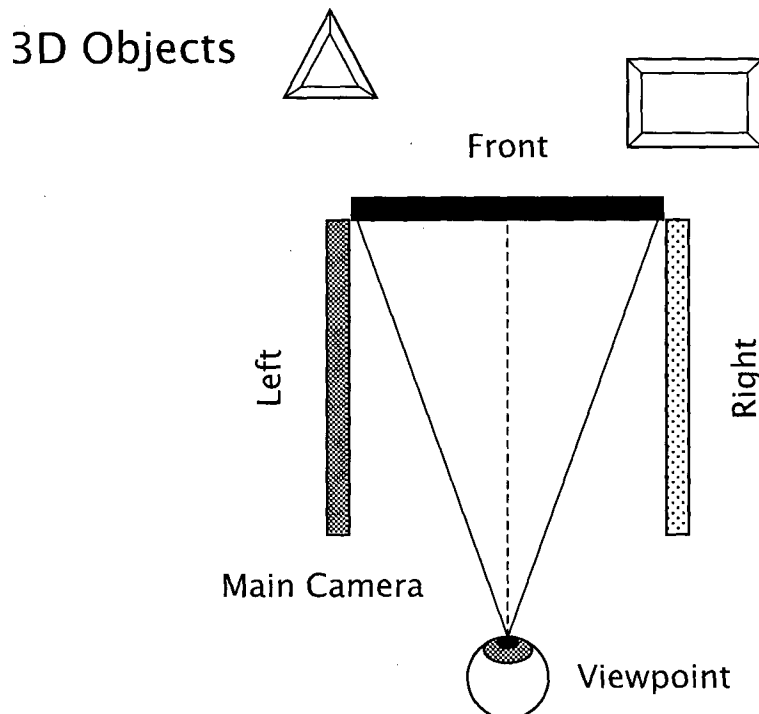


FIG. 8



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FIG. 9

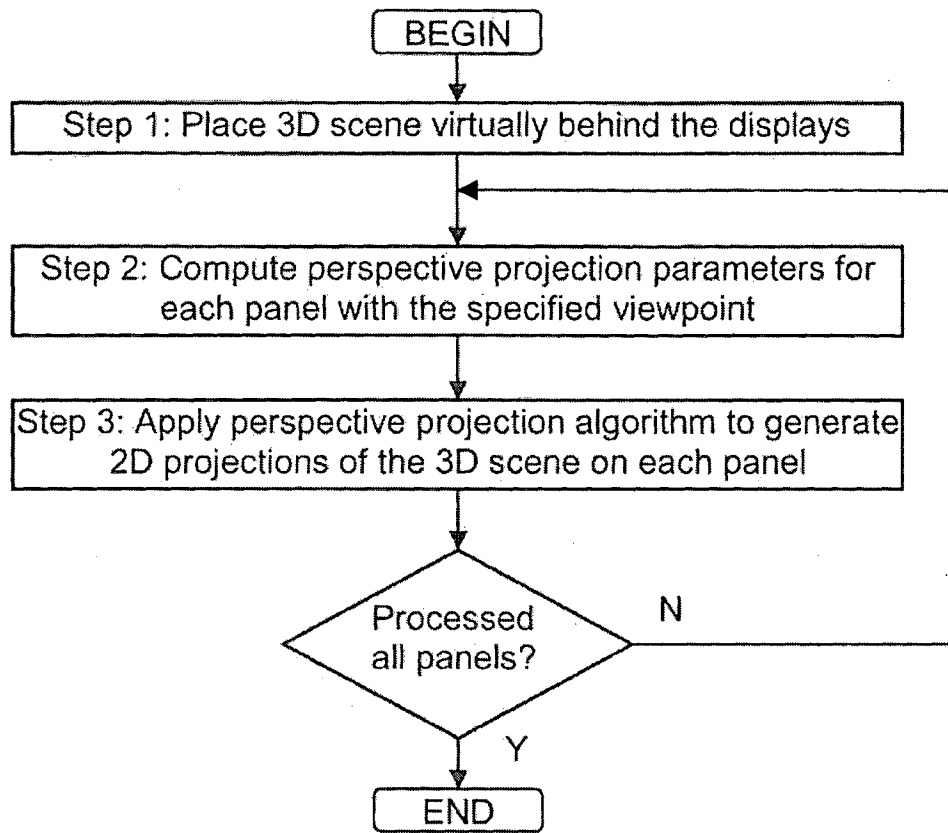
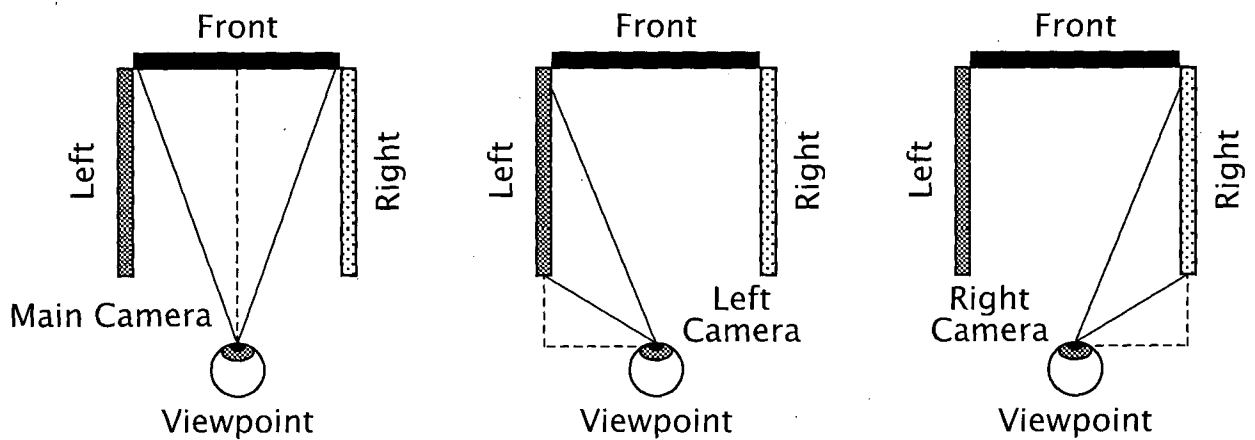


FIG. 10



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FIG. 11

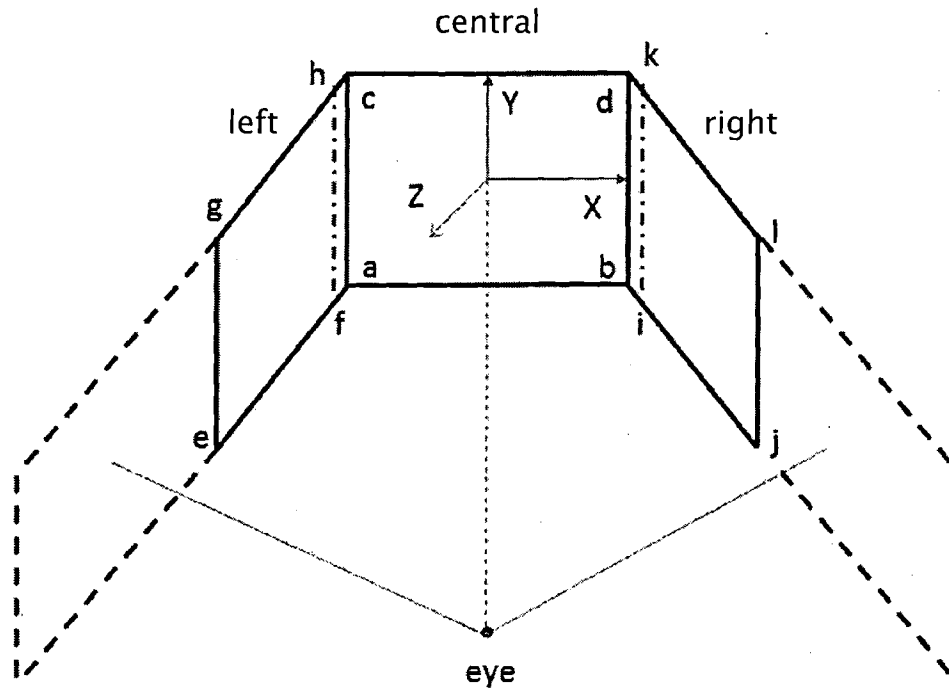
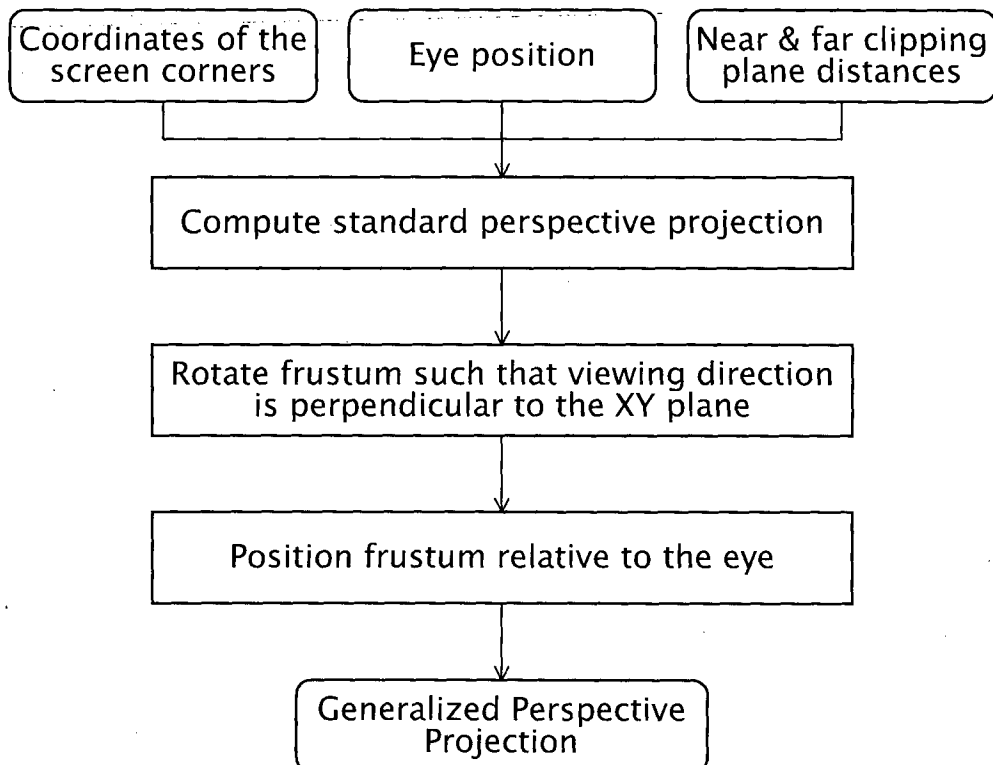


FIG. 12



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FIG. 13

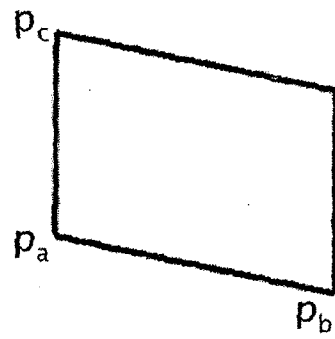


FIG. 14

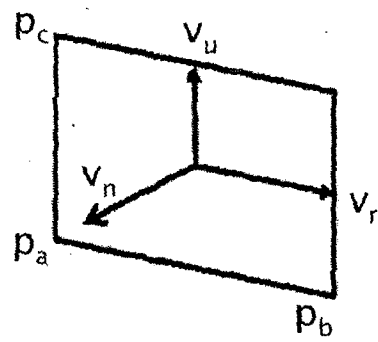
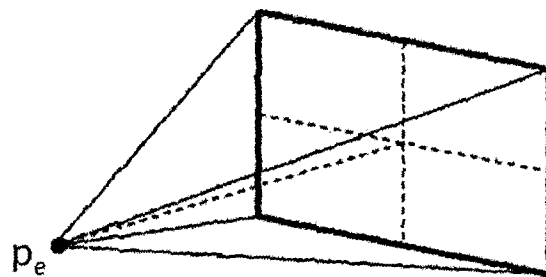


FIG. 15



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FIG. 16

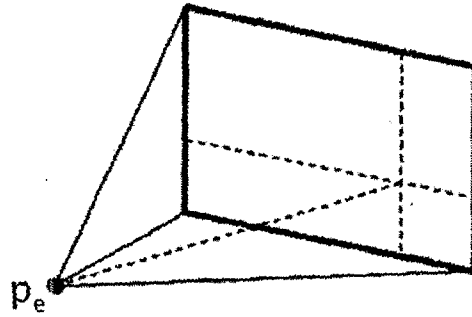


FIG. 17

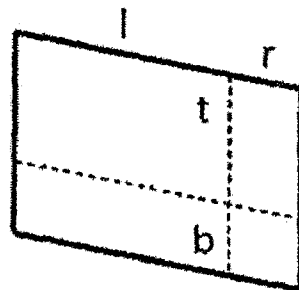
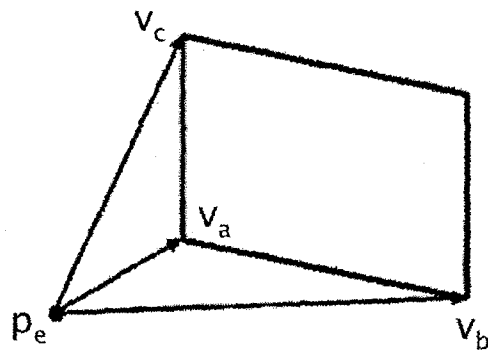


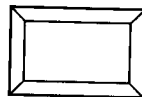
FIG. 18



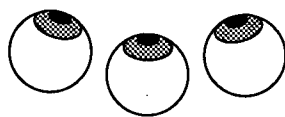
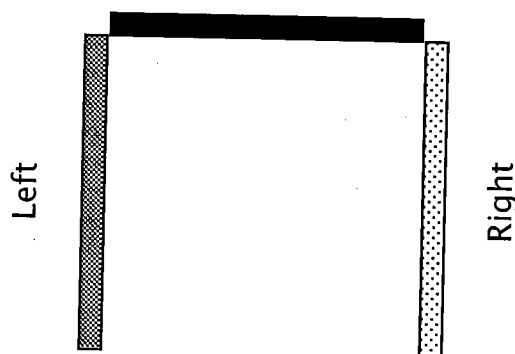
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FIG. 19

3D Objects



Front



Multi-Viewpoint

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FIG. 20

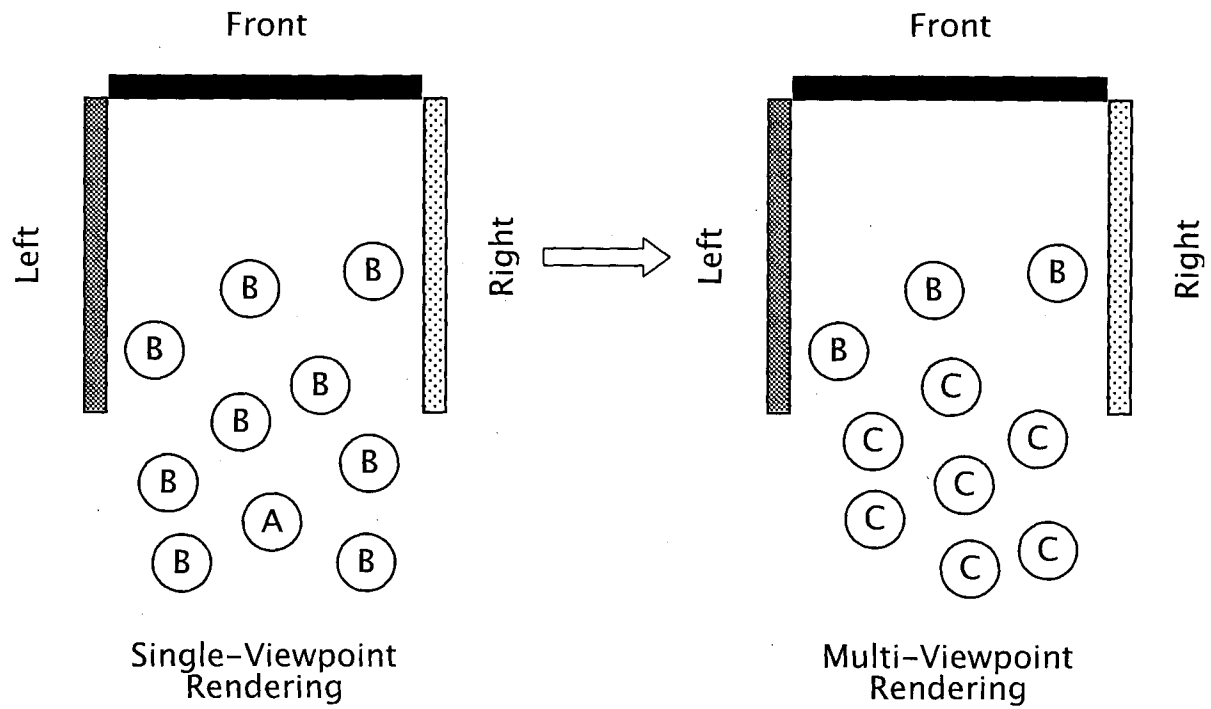
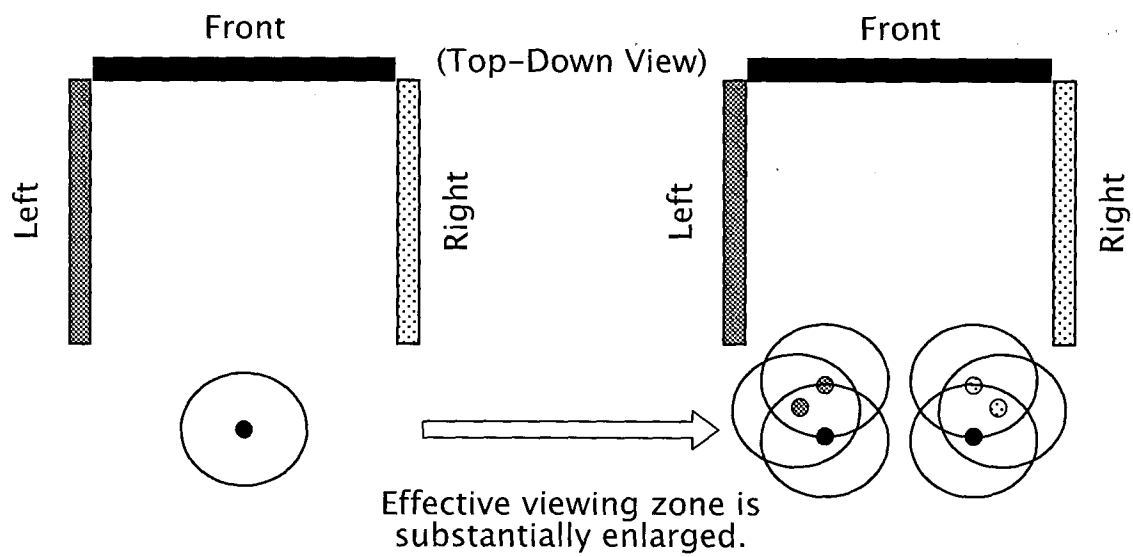
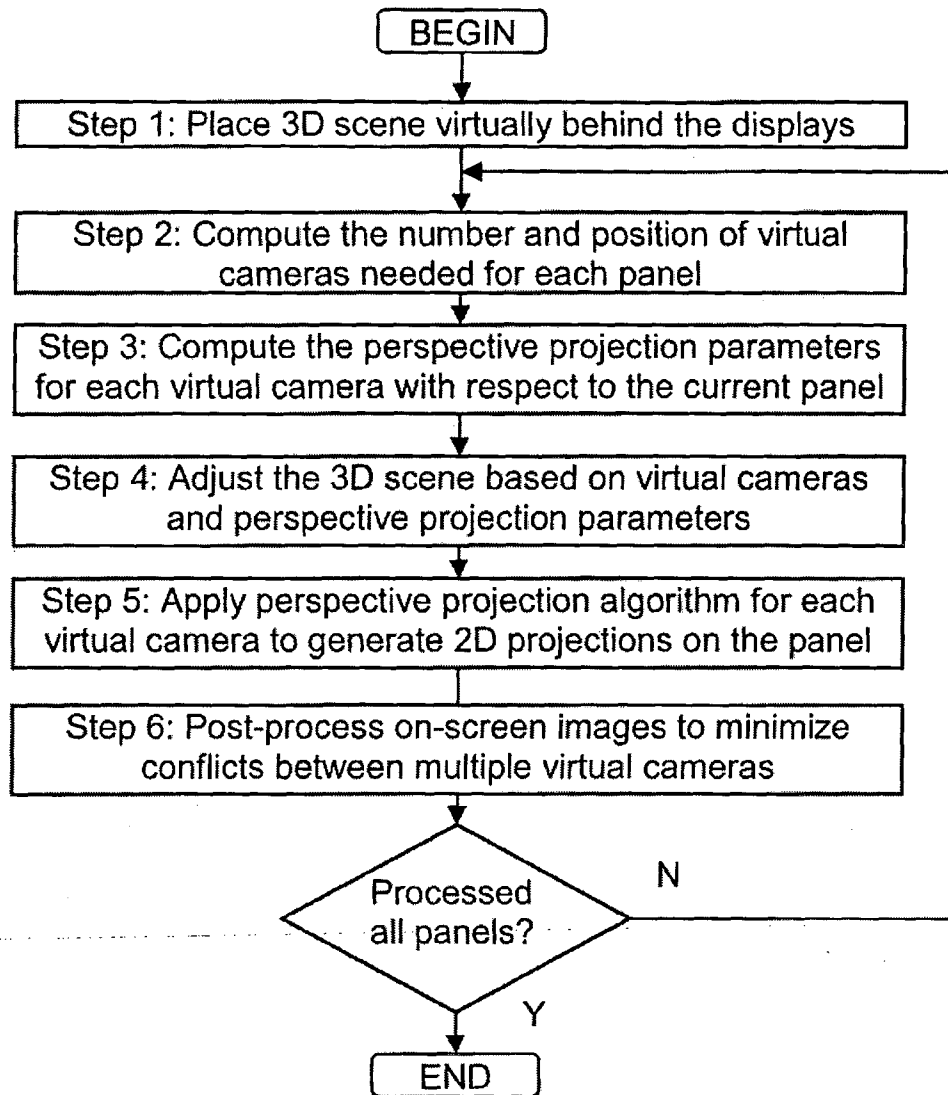


FIG. 21



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FIG. 22



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FIG. 23

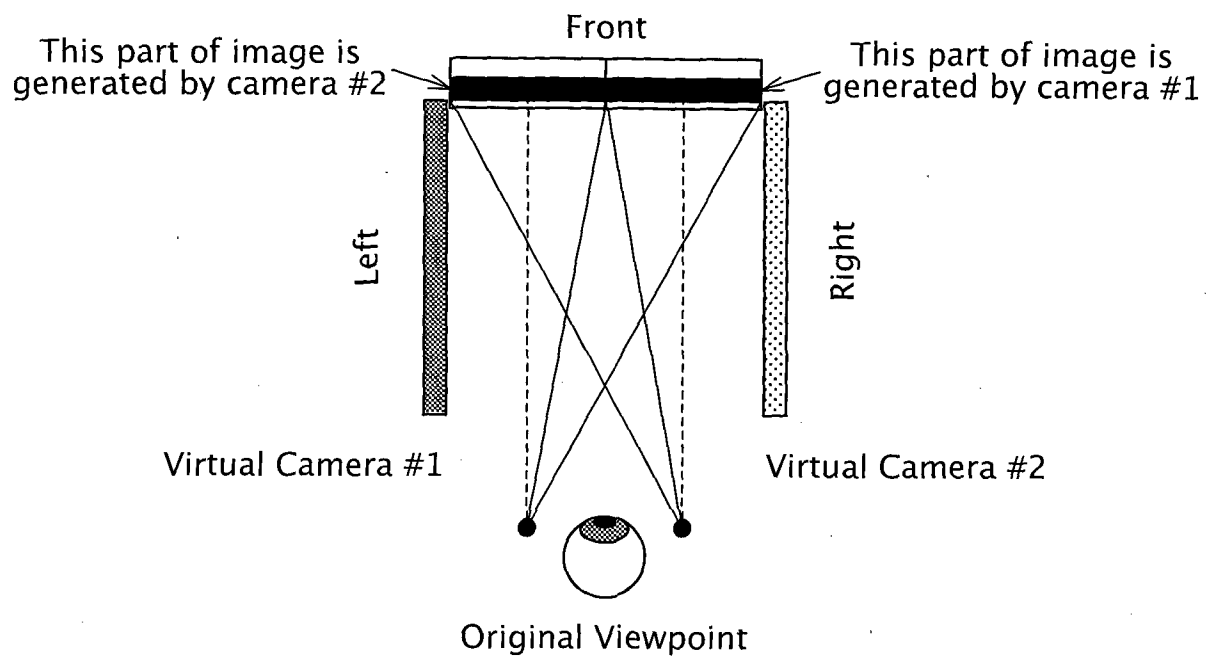
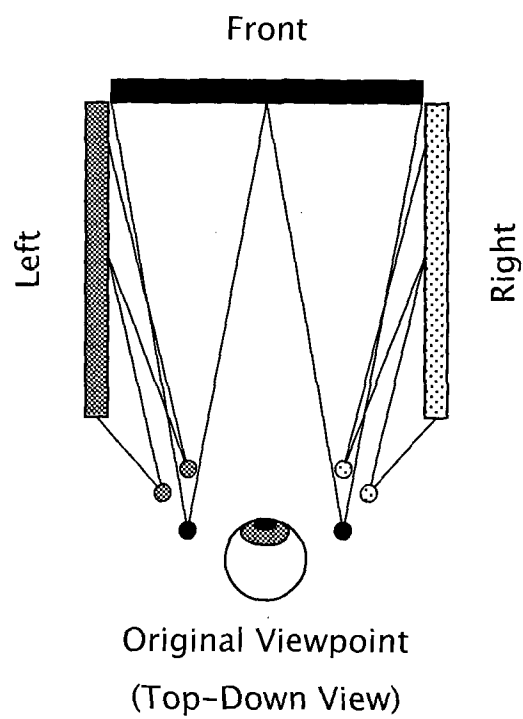
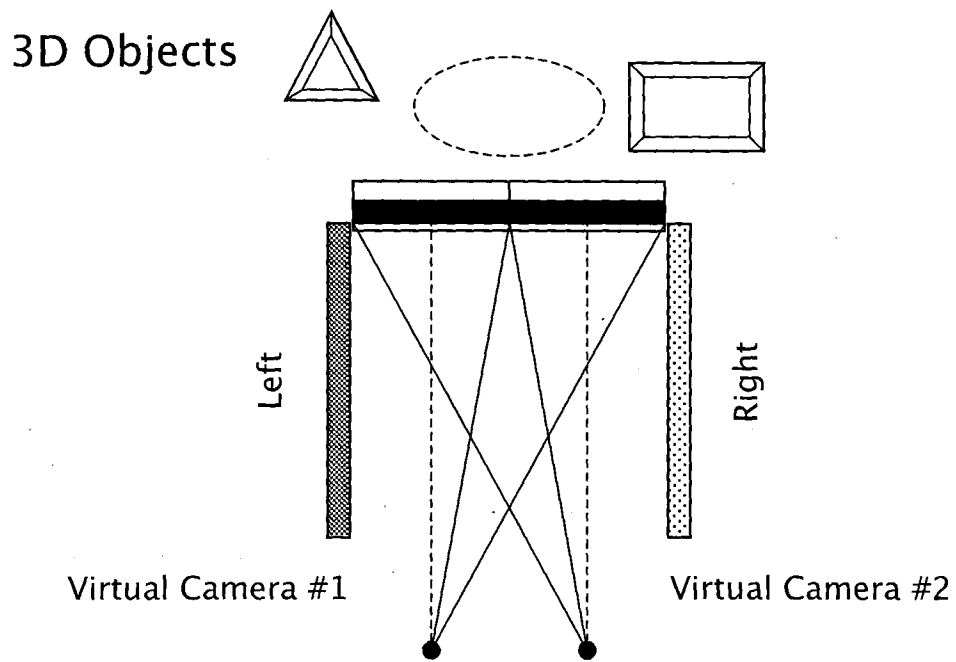


FIG. 24



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FIG. 25



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/065297

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G09G5/00 (2006.01) i, G09F9/40 (2006.01) i, G09G5/36 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. G09G5/00, G09F9/40, G09G5/36

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2012
 Registered utility model specifications of Japan 1996-2012
 Published registered utility model applications of Japan 1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2011-35590 A (Sharp Corp.) 2011.02.17, 【0022】 - 【0030】 , 【0034】 - 【0036】 , Figs.1-3 (No Family)	1-15, 21-22
X	JP 2005-115069 A (Seiko Epson Corp.) 2005.04.28, 【0005】 - 【0055】 , Figs.1-8 (No Family)	1-5, 8-15, 21-22
A	JP 2001-356410 A (Nippon Telegraph and Telephone Corp.) 2001.12.26, whole document and figure (No Family)	1-22
A	JP 11-298780 A (NHK Engineering service Inc.) 1999.10.29, whole document and figure (No Family)	1-22



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

12.07.2012

Date of mailing of the international search report

24.07.2012

Name and mailing address of the ISA/JP

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan

Authorized officer

Takeshi Fukunaga

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2G

3490

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/065297

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10-177660 A (Takenaka Corp.) 1998.06.30, 【0012】 - 【0020】 , Figs.1-12 (No Family)	1-22

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/065297

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The subject matter common to claims 1-22 is the subject matter of claim 1.

However the search has revealed that the subject matter described above is disclosed in documents below and therefore appears to be not novel.

D1: JP 2011-35590 A (Sharp Corp.) 2011.02.17,
【0022】 - 【0030】 , 【0034】 - 【0036】 , Figs.1-3

D2: JP 2005-115069 A (SEIKO EPSON CORP.) 2005.04.28,
【0005】 - 【0055】 , Figs.1-8

(Continued)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Box.No.III (Continuation)

As a result, this subject matter does not overcome the prior art and is therefore not a special technical feature within the meaning of the second sentence of PCT Rule 13.2.

Consequently, there is no subject matter common to all of claims 1-22. Therefore there is no other subject matter common to all the claims. Since there exists no other common feature which can be considered as a special technical feature within the meaning of the second sentence of PCT Rule 13.2, no technical relationship within the meaning of PCT Rule 13 between the different inventions can be seen.

Consequently, it appears that, a posteriori, claims 1-22 do not satisfy the requirement of unity of invention.