

IMPROVEMENTS IN THREE DIMENSIONAL IMAGERY

THE PRESENT INVENTION relates to a method and an apparatus for producing imagery with three visual dimensions.

BACKGROUND TO THE PRESENT INVENTION

Three-dimensional imagery is a term that has been in use for more than a century: during this time, it has developed a complex range of meanings.

These connotations vary from a general implication of depth in imagery to particular types of imagery, some of which entail opposing ideas.

For example, the term is used to describe depth in imagery acquired from a single viewpoint, without consideration of other viewpoints.

In contradistinction, other imagery is described as three-dimensional, in which no visual depth appears, but where different viewpoints are displayed.

For the purpose of description and definition, the term "three-dimensional imagery" as used throughout this specification, is intended to define imagery that:

"simultaneously contains at least two adjacent angles of view, acquired from points spaced sufficiently about a common centre, or continuum of common centres, to display three apparent dimensions within a coherent visual volume; without any appearance of more than one image."

Most three-dimensional imagery of this type is accomplished with viewers, visors and spectacles. They include simple wood

and glass devices of last century, like the "Holmes viewer", to helmets mounting electronic shutters, synchronised to film, or video, frame changes.

These systems generally function by blocking views left of the object centre to the right eye, and views right of the object centre to the left eye.

The disadvantages of these arrangements include having to use, or wear, them; to limitations on angles of view; to incompatibilities with individual visual idiosyncrasies.

Such problems have long been impediments to the general proliferation of three-dimensional imagery.

After viewers, probably, the next most ubiquitous approach is the lenticular array, an optical grid, dating to the earliest history of three-dimensional imagery.

Three-dimensional grid contrivances work on a similar principle to viewers. To greater or lesser extents, grids isolate views acquired left of object centres to left eyes; and isolate views right of object centres to right eyes.

The main difference between grid, compared to viewer systems, is the position of the view differentiating opticals. Grids have been generally placed in front of imagery, while viewers are worn or placed in front of the eyes.

A portrait incorporating a grid concept is reported to have been produced by the Danish painter, S.A. Bois-Clair, in 1692. The painting is described as presenting a row of narrow, vertical, alternating strips of two views of a person, each strip separated by a vertical lath.

The common concept embodied here is that the wood dividers mask left side picture strips from right eyes, and right side picture strips from the left eyes. This segmentation and separation of two off-set paintings, if actually constructed well enough to work, would have expressed three-dimensional grid theory in action. Further, it would have demonstrated the inherent limitations of simple grid systems.

The first drawback of the design above is the presence of the grid itself. It must be prominent enough to block each eye to half the imagery and is, therefore, just as visible as the imagery. For this reason the quality of the effect is reduced to the extent that the grid must be in focus.

A second disadvantage of simple three-dimensional grid systems is the lack of optical uniformity. For full three-dimensional imagery to be seen, every element of each view must be equally evident to the corresponding eyes. This restricts image sizes and viewing angles to being small, around the image centres.

In practice, large, high quality, three-dimensional images, that numbers of observers can view from wide angles, are not possible for simple static grid arrangements.

Lenticular arrays allow a substantial improvement that overcomes the first grid defect to some extent; although, again, generally, for small images. The improvement is realised by replacing solid grid segments with transparent, thin, vertical, lens strips. The lenses are angled, so that left views are in focus to left eyes when right views are in focus to right eyes.

While most of the glass grid is unseen, because it is transparent, the edges where the lens strips join are not.

These edges and joins partially obscure the image, as well, they can introduce other undesirable effects, including spectral aberrations.

Moreover, all the other limitations of simple three-dimensional grid systems still apply.

A further partial improvement is available from a dynamic grid system called "The Cyclostereoscope".

Here, the presence of a grid can be removed from view completely, by revolving it around a screen at sufficient speed to make it invisible to the eyes. Such an improvement was proposed in French patent specification No 607,961 of Francoise Savoye, dated October 8, 1942.

This design provided an effective solution to the problem of grid visibility. Like the lenticular array, the cyclostereoscope introduced new detractions and did not solve any more of those characteristics of the simple grid concept. Again, the improvement was confined to small images, presenting partial three-dimensional effects.

The mechanical limitations of the cyclostereoscope have been overcome by improvements described in international patent specification No PCT/AU92/00199 and Australian patent specification No PL6295.

These improvements provide three-dimensional imagery that can be viewed from a wide angle without wearing visors, or similar personal view differentiating opticals.

SUMMARY OF INVENTION

According to one aspect of the present invention there is provided a grid arrangement for use in three-dimensional imagery, including a grid formation formed of a plurality of spaced apart slats between a viewer and said imagery, and wherein said slats are laterally spaced apart one from the other, having dimensions of both width and length.

According to a further aspect of the present invention there is provided a grid arrangement for use in three-dimensional imagery, including a grid formation formed of a plurality of spaced apart slats between a viewer and said imagery, and wherein said slats are laterally spaced apart one from the other, having dimensions of both width and depth; said grid arrangement being formed so that the spacings between said slats are tapered.

It should be appreciated that in all forms of the invention, the grid arrangement of the present invention can be separate from or incorporated into an appropriate screen arrangement, or alternatively can be programmed into an appropriate computer software package or programme to provide the grid for achieving the objects of the present invention. Alternatively, any appropriate known or available mechanical, electrical or liquid crystal means may be used to form the inventive grid arrangement of the present invention.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The invention will be described by way of example only and with reference to the accompanying drawings, wherein:

Figure 1 is a view which demonstrates a simple, static, optical grid arrangement,

- Figure 2(I) illustrates a similar arrangement to Figure 1 on a different scale,
- Figure 2(II) illustrates a similar arrangement to Figure 2(I) but distinguished by a larger viewing distance,
- Figure 2(III) illustrates a similar arrangement to Figure 2(I) but distinguished by a far greater viewing angle,
- Figure 2(IV) illustrates a similar arrangement to Figure 2(I) also distinguished by a greater screen width,
- Figure 3 demonstrates an arrangement where there is a divergence of conditions in Figures 1 and 2,
- Figure 4 demonstrates a further arrangement with a greater width of image segments,
- Figure 5 demonstrates an arrangement with small image segments separated equally,
- Figure 6 illustrates an arrangement representing two images of adjacent angles of view,
- Figure 7 illustrates an arrangement showing a short fall in a simple static grid arrangement,

- Figure 8 illustrates an arrangement demonstrating two sections of grid elements containing vertical elements,
- Figure 9 demonstrates an arrangement of grid sections with vertical depth,
- Figure 10 demonstrates another arrangement of the present invention,
- Figure 11 demonstrates a further arrangement of the present invention,
- Figure 12 illustrates a further arrangement of the present invention and in particular a situation common to optical grid systems, and
- Figure 13 illustrates an arrangement according to a further form of the present invention.

DESCRIPTION OF THE INVENTION

This invention provides a number of improvements to three-dimensional imagery that can be produced by transposing optical grids before imagery containing discernibly displaced adjacent angles of view.

Preferably, the adjacent angles of views are displayed in separated segments, alternatively, and transpose fast enough for the transposition to be unnoticeable for the human eye.

Preferably, the transposition of the separated, alternate, image segments is substantially synchronous with transposing

grid elements. The grid segments are preferably shaped, profiled and positioned, to reveal from any viewing position substantially every element and aspect of the imagery.

Adjacent angles of views left of object centres are revealed only to the left eye of an observer, while substantially simultaneously, all imagery acquired right of object centres is revealed only to the right eye of an observer.

The invention permits three-dimensional imagery to be seen without visors, from a wide angle, without limiting the image area viewed.

The invention further permits three-dimensional imagery to be seen without visors, from any distance without limiting the image area viewed.

The present invention allows for any desired viewing position, every element and aspect of imagery, acquired left of object centres, to be continuously and completely revealed to the left eyes of observers, while simultaneously, continuously and completely, obscuring every element and aspect of that left of object centre imagery from their right eyes. Substantially simultaneously, every element and aspect of imagery acquired right of object centres is revealed to the right eyes of observers. Again, simultaneously, as well as again continuously and completely, every element and aspect of this right of object centre imagery is obscured from their left eyes.

The present invention further preferably provides that the minimum angle required to produce visibly different images can be varied. This variation is without limitation, to the maximum displacement possible at the object acquisition distance, for optimum three-dimensional effect. Additionally,

the variation is provided without restricting the areas of imagery available to either eye.

The present invention further provides for the display of vertical three-dimensional effects, simultaneously with horizontal three-dimensional effects, without restriction.

The present invention further provides focal planes within the imagery to be in focus simultaneously. If required otherwise, focal planes can be in combinations of focal conditions, without limitation.

The present invention further provides an improvement which permits the apparently seamless joining of individual images, whether three-dimensional, or two-dimensional. This improvement permits imagery of non-standard format (such as on wide, large, curved, or special purpose screens), to further enhance realism, or produce other special effects.

The shape and positioning of grid segments are important to the success of the present invention and will now be described and discussed further as follows:

Known grid technology

It is well known that grid patterns can be placed in front of imagery containing adjacent angles of view to produce three-dimensional effects.

Until now, these effects have been limited and restricted from application with advantage to television, computer screens, video monitors and many other forms of imagery in common use.

Improvements that have been incorporated in three-dimensional imagery grid systems include lens array adaptations, usually in lenticular forms, and dynamic grid arrangements.

Neither of these two approaches satisfy requirements for general imagery systems applications.

In case of lens, and lenticular, arrays, a major drawback is focal point sensitivity which limits viewing to a small arc around the centre. Practical application requires inordinately large, and expensive, screens to give an adequate viewing angle to even small audiences.

Inertial forces and other fundamental incompatibilities of mechanical grid systems with conventional electronic screens are overwhelming disadvantage for systems like the cyclostereoscope.

At least some of these impediments are overcome or at least minimised by improvements set out in international patent specification No PCT/AU92/00199 and in Australian patent specification No PL6295.

This provides three-dimensional imagery that can be viewed from a wide arc and at large distances in relation to image size.

As well, these improvements lend themselves to take advantage of the physiognomy of normal human perception.

For instance, the propensity of the eyes to focus on imagery, tends to enhance its perceived quality, whatever the defects caused by grids in front of it.

The ability of the mind to retain partial visual impressions, additively for cumulative recognition, helps perception of grid systems imagery, if it is partial, or sequential.

As well, normal eye movement can contribute substantially to the horizontal scanning essential to all such grid designs.

The improvements set out in international patent specification No PCT/AU92/00199 and Australian patent specification PL6295, together with the natural tolerance and compensation of human vision, provide an extremely flexible system that can appear to work very satisfactorily, well beyond technical optimums.

These optimums determine the quality of three dimensional imagery. As well, they define the limits of image sizes; viewing angles; viewing distances; applications; audience sizes; compatibility with human vision, and conventional equipment.

For the purposes of this invention, these technical optimums apply when -

- i): All imagery left of object centres is at the maximum angle of divergence possible from all imagery acquired right of object centres for any object acquisition distance, and
- ii): All imagery acquired left of object centres is seen by left eyes only, and completely; while all imagery acquired right of object centres is seen by right eyes only, and completely.

It will be appreciated that these criteria are incompatible with simple static grids. Therefore, an improved dynamic grid

arrangement is provided which is essential to acquire the desired standard(s) in addition to the other features of the present invention, as referred to above.

Simple static grid arrangement

In the accompanying drawings, referred to herein, the following symbols are used:

L	Left eye position
R	Right eye position
$a_1 a_2 a_3 a_4 a_5 a_6$	Image segments seen by left eye
$b_1 b_2 b_3 b_4 b_5 b_6$	Image segments seen by right eye
$c c c c c$	Grid segments
d	Image width
e	Viewing distance
f	Grid distance from the screen

Figure 1 demonstrates a simple, static, optical grid arrangement.

A left eye position, L, is spaced from a right eye position, R, at typical pupil separation of two and a half inches.

The eye positions, L and R, face screen AB, fifteen inches wide; at a viewing distance, e, of thirty inches. Grid segments at c, c_1 , c_2 , c_3 , c_4 and c_5 separate the viewing arcs from positions L and R to image segments a_1 , b_1 , a_2 , b_2 , a_3 , b_3 , a_4 , b_4 , a_5 , b_5 , a_6 and b_6 .

The view from left eye position, R, is confined completely to image segments a_1 , a_2 , a_3 , a_4 , a_5 and a_6 .

The view from right eye position, L, is confined completely to image segments b_1 , b_2 , b_3 , b_4 , b_5 , and b_6 .

The grid segments, separate, and isolate views from position L exclusively to position L; and segments, separate, and isolate views from position R exclusively to position R.

The width and position of the grid segments permit unrestricted viewing from position L, of image segments a_1 , a_2 , a_3 , a_4 , a_5 and a_6 .

Similarly, the width and position of the grid segments permit unrestricted viewing from position R, of image segments b_1 , b_2 , b_3 , b_4 , b_5 and b_6 .

This arrangement demonstrates imagery segmented and separated in alternate, vertical, strips for complete and separate viewing from two positions, without restriction on the total area of any image segment.

For this simple, static, optical arrangement, grid sections in focus will be seen.

Grid sections of less width than those at c , c_1 , c_2 , c_3 , c_4 and c_5 can be positioned at greater distances from imagery on the screen AB, with identical effects to those grids segments at positions c to c_5 .

An image of the width above - 15" - with a viewing distance of 30", could be typical of a video monitor for data or word processing, however, the screen width can be any width, and the viewing distance, any distance at which imagery can be discerned.

It can be seen, therefore, that within the constraints of normal vision, a screen of any width can be positioned at a

distance where, grid segments of correct width, can be located to completely and exclusively separate left and right eye views of alternate segments of imagery of equal width and area.

Similarly, a screen can be positioned, at any distance, or angle from where imagery can be discerned, and grid segments, of correct width, located to completely and exclusively separate left and right eye views of alternate segments of imagery of equal width and area.

Figure 2 demonstrates that these conditions apply for any simple, static, grid arrangement of this type.

Figure 2 I illustrates a similar arrangement to Figure 1 on a different scale. Here, eye positions L and R face image segments a_1 , b_1 , a_2 , b_2 , on screen AB; twenty-five inches wide; at a viewing distance e , of five feet. This situation could be typical of household television viewing.

Figure 2 II illustrates a similar arrangement to figure 2 I, but distinguished by a far larger viewing distance. Here, eye positions L and R face image segments a_3 , b_3 , a_4 , and b_4 on screen CD; twenty-five inches wide; at a viewing distance, e_1 , of ten feet.

Figure 2 III illustrates a similar arrangement to Figure 2 I again, but distinguished by a far greater viewing angle. Here, eye positions L and R, face image segments a_5 , b_5 , a_6 , b_6 , on screen EF, twenty-five inches wide, at an angle of 45° .

Figures 2 IV illustrates in similar arrangement to Figure 2 I, also; distinguished by a greater screen width. Here, eye

positions L and R, face image segments a_7 , b_7 , a_8 , b_8 , on screen GH, sixty inches wide.

Such an arrangement could apply to a high definition television screen.

As can be seen in all these examples, grid sections can be placed at a position where alternate image segments are completely and equally separated to the corresponding eyes, and each eye sees its corresponding image segments completely and equally.

It can be seen therefore, that these conditions apply to all image sizes, viewing distances, and angles of view.

Figure 3, demonstrates a divergence from the conditions in Figures 1 and 2, where grid sections positioned at c and c_1 , only partially separate views from eye positions a and R of image segments a , b , a_1 , and b_1 . In contrast, grid segments positioned at c_2 , and c_3 , completely separate the views from eye position L and R exclusively.

Figure 4 demonstrates that the greater the width of the image segments to be separated to the left and right eyes, the further from the screen the position for the grid segments for complete, equal, separated, and exclusive viewing by the corresponding eyes.

Figure 5 demonstrates that very small image segments can be separated equally, and completely; as well as viewed completely, separately, and exclusively, by corresponding eyes; when grid sections are close, or very close to image segments.

Here, eye positions L and R view image segments a_1 , b_1 , and a_2 , 0.6 inches wide; at a viewing distance, e_1 , of 9 feet. It can be seen that the grid sections c , c_1 , and c_2 can be positioned close, very close, or almost coincident with image segments a_1 , b_1 , and a_2 on screen AB.

Eye positions L and R at viewing distance e_1 , of 4.5 feet, and angle to the screen AB of 45° , require essentially identical grid segment positions for separate and exclusive left and right eye views of corresponding image segments a_1 , b_1 and a_2 to those for left and right eye positions L and R.

Eye positions L and R of viewing distance e_2 , twelve feet, from image segments a , b_1 and a_2 , on screen AB, require grid segment positions to separate exclusive left and right eye views of the image segments, again, essentially identical to those for left and right eye positions L and R.

It can be seen, therefore, that where alternate image segments are small, small grid segments can be placed very close in front of the image segments, to provide complete, completely separated, and exclusive views to left and right eyes of separated, alternate, image segments, over large viewing distances, and at wide angles of view.

Further, the smaller the image segments, the smaller the grid segments required, and the flexibility of viewing positions. It can be seen that the arrangement depicted in Figure 5 could apply to any similar arrangements, including any viewing distances, or angles of view where image segments can be seen. Consequently, it can be seen, too, that for small and very small image segments, there are no limitations on the viewing positions through corresponding small grid segments, where, within the bounds of human vision discernment, complete, completely separate and exclusive, are

views provided for the left and right eyes of corresponding alternate segments of imagery, and where each eye sees exactly half of the total image segments.

It follows that it is possible to position grid segments in front of any uniform imagery, that can be seen, so that the eyes see, see completely, and exclusively, equal numbers of image segments.

It also follows that it is possible to position small grid segments close to imagery, so that the eyes see, see completely and exclusively, equal numbers of image segments from wide angles and various viewing distances.

It is essential for all these arrangements that the width and area of image segments are the same; and the width and area of the grid segments are the same.

This requirement is incompatible with the application of simple, static, grids to three-dimensional imagery. The displacement of corresponding visual elements, in images containing adjacent angles of view about a common centre, increases from the image centre.

Figure 6 represents two images, of adjacent angles of view about a common centre, of equal height and width, displayed on a screen. IL is imagery acquired left of the object centre; IR is imagery acquired right of the object centre.

In any such arrangement, the geometric vertical image centre lines C , C_1 , C_2 , and C_3 can be aligned coincidentally.

With vertical centre line C and C_1 , aligned coincidentally with C_2 and C_3 , all image elements offset from the geometric vertical image centres will diverge according to the angle of

divergence between the two images, the distance of the image element from the centre line and in the direction of the image centre from the common object centre.

In Figure 6, e is an image element of image IL , an image acquired left of the object centre.

The distance, d , between image element, e , and image vertical centre C, C_1 , will be greater than the distance, d_1 , between image element, e_1 , and the image vertical centre C_2, C_3 .

Similarly, the distance d_3 , will be greater than d_2 .

As well, both the distances, d_2 , and d_3 , will together be greater than the distances d , and d_1 .

It can be seen, therefore, that corresponding image elements of imagery containing adjacent angles of view about a common centre, cannot be aligned to coincide at more than one position;; and the discrepancy in coincidence of non-aligned points increases from the image centre; as well as with increasing divergence between the image centres.

From this, it can be seen that it is not possible to place grids of equal segment width in front of alternate segments of imagery containing two adjacent angles of about a common centre; so that the grid segments separate the view acquired left of the object centre to the left eye; and the view acquired right of the object centre to the right eye, in each case exclusively, and in each case so that all image segments are seen completely by the corresponding eye.

Obviously, it is possible in the case of a simple, static, grid to place grid segments of unequal length, so that image segments, containing imagery acquired left of object centres,

are seen completely and exclusively by the left eyes; and image segments, containing imagery acquired right of the object centres, are seen completely and exclusively by the right eyes.

However, the arrangement above is visible from only one viewing position; so it is not possible for the arrangement to provide the required exclusive and complete separation from any position.

Figure 7 shows another failing of the simple, static, grid when applied to imagery containing discernibly different adjacent angles of view.

If grid segments are of equal width, positioning in front of imagery containing adjacent angles of view, acquired at wide divergences from the common centre, can result in each eye seeing both left and right views simultaneously.

In Figure 7, grid segment c , placed between image segments a_1 and b_2 , completely and exclusively separates the left and right eye positions L and R to the corresponding image segments a_1 and a_2 , for L and b_1 for R .

Image element e_1 appearing in image segment a_1 and seen by the left eye position L , does not have a corresponding image element in image segment b_1 , to be seen by the right eye.

Image element e_1 and e_2 appear in image segment a_1 , because of the greater distance from the image centre line in proportion to the distance of e_2 from the centre of line C . This is a typical example of so-called "double imaging" in partial three-dimensional imagery arrangements.

The following improvements overcome these limitations.

The following individual improvements to known technology can be applied in combinations of each individual improvement according to the final optical and three-dimensional quality required.

The first of these is to apply vertical dimension to dynamic grid segments.

Dynamic grid segments with vertical dimension

Transposing grid sections in front of alternate segments of imagery, containing visibly distinct adjacent angles of view, averages the blocking effect of each grid segment along its path. If the speed of transposition is sufficient to be unseen by the eye, the grid segments disappear and produce a view of the imagery which is a total of the average blocking effect of each grid segment along its path of travel.

Positioning the grid close, or very close, to the image segments limits the extent to which the eyes can see around the grids, producing the effect of vertical depth, or dimension, in the grids, and to that extent a "tunnel view". This improves the effectiveness with which the grid elements accurately separate the left and right image segments to the corresponding eyes.

Where scope to improve left-right separation by reducing the distance of the grid from the screen is constrained, then, the efficiency of the grid can be enhanced by increasing the physical depth of the grids.

Increasing the physical dimensional of each grid segment, by the vertical component extending away from the eye and in the

direction of the imagery, creates a "tunnel view"- effect between any two grid segments, that can completely separate views of each image segment to the corresponding eye, providing the vertical extensions are long enough.

Figure 8 of the drawings demonstrates two sections of grid elements G_1 and G_2 , both containing vertical elements extending from the viewer forward the screen, and where G_1 is closer to the screen than G_2 .

As can be seen, vertically extended grid sections G_2 separate both left and right views from L and R completely and exclusively, while vertically extended G_1 do not.

The depth and width of the grid sections can be sized, according to the width of the image segments, and the required position of the grid from the screen.

If the grid sections are of equal depth and width, and the same width and height as the image sections, then grid sections containing vertical depth can be placed any distance from the image segments to completely segment and separate the image segments to corresponding eyes, providing the grid segments have both appropriate depth and width.

Grid sections of appropriate depth and width for image segments, containing discernibly different adjacent angles of view, can be placed to separate images completely to the respective eyes to produce three-dimensional imagery.

Transposing the grid elements, in synchronisation with transposing image segments, will produce a three-dimensional image, in which the grid segments cannot be see, providing the speed of transposition is sufficiently fast.

Increasing the angle of view in three-dimensional imagery formed by dynamic grid sections with vertical depth

Increasing the vertical depth of dynamic grid sections for the production of three-dimensional imagery, decreases the viewing angle at which the imagery can be seen unless the grid sections containing vertical depth are shaped to maximise the angle of view.

Figure 9 demonstrates an arrangement of grid sections with vertical depth, having a tapered form to permit wide angle viewing. Such tapered shapes can be either equilateral or isosceles, and of size depending on the angle of view required, the size of the image and image segments, and the viewing distances involved.

It may be preferred to have the grid shapes easily adjustable for different situations.

As well as having tapered edges facing observers, the grid sections with vertical depth may taper in the other direction, for instance if the screen is curved. As well, the grid segments can be oval, instead of wedge shaped, or diamond shaped, according to viewing requirements.

Transposing grid elements containing vertical depth so as to reveal all image segments completely to the appropriate eyes

Figure 10 demonstrates that for any one position of the grid, parts of the image segments may not be seen; resulting in a partial view of the imagery. This applies particularly when grid segments contain vertical depth.

A complete view of each image segments can be obtained by either of two methods.

Firstly, by transposing the grid segments along a continuous path of length equivalent to at least the horizontal width of each grid segment, all grid segments being of equal width. The transposition may be continuous, in one direction, or oscillating.

Secondly, by transposing the grid segments as changes between fixed positions, such as positions formed on an electro-optical display, like a liquid crystal display panel or similar inertia free means of forming a dynamic optical grid.

In the second case, where grid sections transpose between fixed points, it is important that the distance of transposition is equivalent to the width of the grid sections, and that each individual movement of the grid segments, within the total transposition, is no larger than the length of the widest piece of imagery obscured from view by the grid, at any position, from the required viewpoint of maximum angle from the image centre.

Where the number of steps that the grid segments can take in any completion of the total path of transposition, is limited by available refresh rate, then further alternatives are to vary the grid positions at a speed at which they cannot be seen, or vary grid segment widths, in a fixed ascending, or descending ratio, according to the number of movements in the complete cycle, as shown in Figure 11.

Where the shape, or position, of the grid is changed during the full transposition cycle, the alternating segments of imagery behind the grid must change in exactly the same way simultaneously.

Dynamic forty-five degree segments containing vertical depth

Figure 12 depicts a situation, common to optical grid systems, where a fixed viewpoint, encompassing the positions L and R, can, because it is fixed, result in only partial, or sequential views of imagery being seen at that point.

Where the transposition of grid segments passes a fixed point during the transposition cycle, such as the position of an eye, or a position between eyes, then the view from that position will be constant. This can result in a left, or, right view only being seen from that position, or left and right view sequentially, or no view of an area of imagery.

A solution to this problem is provided by a grid arrangement, where grid segments angled at 45° to the horizontal, transpose before alternate segments of imagery, sized shaped, and angled identically to the grid segments, and transposing also, in synchronisation with the grid segments, at a speed where the transposition is invisible to the eyes, to produce simultaneous vertical and horizontal scanning or oscillation of the imagery. This arrangement, including vertical scanning of imagery, also permits the production of three dimensional imagery containing both horizontal and vertical separation.

Figure 13 illustrates this arrangement, demonstrating that any two eye views, from any position, will simultaneously contain both left views for the left eye, and right views for the right eye, and in no circumstances can either eye be restricted to partial, or sequential views.

In all circumstances, these provisions can be provided by a grid system placed in front of imagery containing discernibly different adjacent angles of view, where the grid transposes at a speed sufficient to be invisible to the eyes.

Alternatively the grid system can be incorporated within a layered screen, where the image segment perform the function of grids and imagery, alternately, or simultaneously.

Together, these arrangements provide the display of three-dimensional imagery of maximum angle of divergence for any acquisition distance through a combination of features of the present invention, which include:

1. transposing grid segments, before synchronously transposing alternate segments of imagery, containing distinctly different adjacent angles of view about common centres, all at a speed to render the transposition invisible to the eye: where -
2. the grid segments should be positioned close or very close to the image segments, or have vertical depth, sufficient to separate the two adjacent angles of view exclusively and completely to corresponding eyes; and where -
3. the grid segments are tapered to provide maximum angle of view in any direction; and where -
4. grid and image segments change in shape, or position during transposition, so that no grid or image segment repeats any position in any complete cycle; and where -
5. the grid segments are angled at forty-five degrees to give simultaneously, both vertical and horizontal scanning or alternation of the imagery, also appearing in forty-five degree alternate segments, and where -
6. grid and image segments always maintain equal corresponding areas on the screen and identical corresponding shape at any instant of any transposition.

The provision of unrestricted focus within three-dimensional imagery

Real objects have no focal points; normal vision involves human eyes focusing at will through continuously changing positions.

This provision can be provided in three-dimensional imagery, produced as described above by the following means:-

By varying the focal distances, within the total field of the imagery, from the objects closest to the acquisition point to the objects farthest from the acquisition point. The focal points may vary continuously with frame changes, or have a set variation, or change in any desired manner.

Where the imagery is generated artificially and not recorded from real life, focal planes can be set, or can change continuously according to the result desired.

It should be appreciated that at all times the adjacent angles of view contained within the imagery should remain of identical size and that objects within the imagery remain the same size even if in different focal positions.

In practice, this effect can be produced by automatically varying the foci of the camera lenses with frame changes so that the lenses scan back and forth through the field of view continuously during recording.

Seamless joining of images

The joining of different images on a screen has well known difficulties that are caused primarily by the uneven

illumination of image edges that are always very visible and in practice impossible to hide from view.

In an arrangement involving a grid system appearing before the imagery it is a simple matter to ensure that image edges are always positioned to lie behind grid positions where the edges would be invisible.

It should be appreciated that in the present invention any form of mechanical and/or electrical and/or electronic means can be used or applied to bring into effect the present invention. In particular, the grid arrangement of the present invention can be brought about by any mechanical, electrical, electronic or other means. For example, mechanical means, electrical means, liquid crystal screen means, or computer generated means such as a computer programme generated to provide the grid system within the screen of a viewing arrangement (such as for example a screen or television screen), but still so as to provide the good arrangement between the imagery as viewed and the viewer.

It should be appreciated that improvements and modifications may be made to the invention without departing from the scope thereof as defined by the appended claims.

CLAIMS:

1. An arrangement for viewing imagery, such that said imagery appears in three dimensions to the viewer; including a grid arrangement formed with or providing a plurality of spaced apart slats between a viewer and said imagery; said slats being laterally spaced apart one from the other and having dimensions of width, length and depth.
2. An arrangement as claimed in claim 1, wherein spacings between said slats are tapered.
3. An arrangement as claimed in claim 1, wherein spacings between said slats are tapered to provide the viewer with maximum angle of view in any direction.
4. An arrangement as claimed in claim 1, wherein means are provided to move and transpose said slats and spacings, therebetween.
5. An arrangement as claimed in claim 1, wherein said slats and spacings therebetween, are angled to give substantially simultaneously, vertical and horizontal scanning or alternation of said imagery.
6. An arrangement as claimed in claim 1, including means to move and transpose said slats; wherein said slats and spacings therebetween are angled to give substantially simultaneous, vertical and horizontal scanning or alternation of imagery; and wherein segments of said grid arrangement formed by said spaced apart slats and spacings therebetween and segments of imagery maintain corresponding areas on a screen, at any point of transposition of said grid arrangement.



7. An arrangement as claimed in claim 1, wherein said imagery appears on or relative to, a screen.
8. An arrangement as claimed in claim 1 wherein said imagery appears on a screen surface; said grid arrangement including spaced apart slats, with spacings therebetween; said grid arrangement being provided on said screen surface between said imagery and a viewer and being provided by means of computer software and/or programme.
9. An arrangement as claimed in claim 1, wherein said imagery is segmented imagery containing at least two spaced apart angles of view about a common centre.
10. An arrangement as claimed in claim 1, wherein means are provided to transpose said slats and spacings therebetween, both vertically and laterally, from and relative to changing points, relative to segmented imagery including at least two spaced apart angles of view about a common centre.
11. An arrangement as claimed in claim 1, wherein said grid arrangement includes a plurality of spaced apart slats with spacings therebetween, and which are positioned and profiled so as to have dimensions of width and depth; means being provided to transpose said slats and spacings therebetween, vertically and laterally from and relative to changing points, and relative to segmented imagery containing at least two spaced apart angles of view, about a common centre.
12. An arrangement as claimed in claim 1, wherein means are provided to transpose the slats and spaces therebetween, vertically and laterally.

