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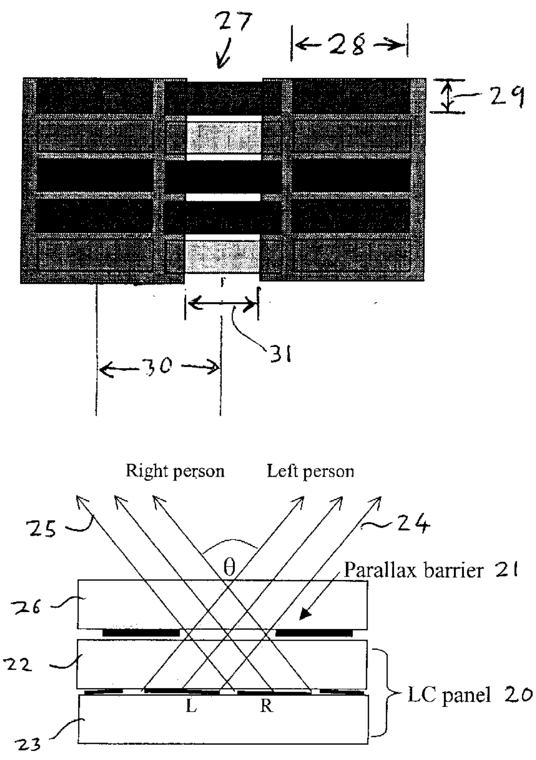
Other: **WPI,EPODOC,PAJ**

(54) Abstract Title: **Multiple-view display and display controller**

(57) Techniques are disclosed for reducing the visibility of crosstalk between images in a multiple view display for simultaneously displaying two or more images independently of each other for viewing in different directions by different viewers. A multiple view display typically comprises a liquid crystal panel (20) and a parallax barrier (21) forming a dual view display for two viewers. The panel (20) comprises an array of pixels of elongate shape and arranged so as to be elongate in the horizontal direction of the normal image orientation on the panel (20). In another technique, left and right views are arranged as interlaced horizontal strips on the panel (20) with a parallax optic (50) in the form of a microlouvre arrangement. Crosstalk compensation may be provided in a display controller for the display by adjusting image pixel values.

Figure 6



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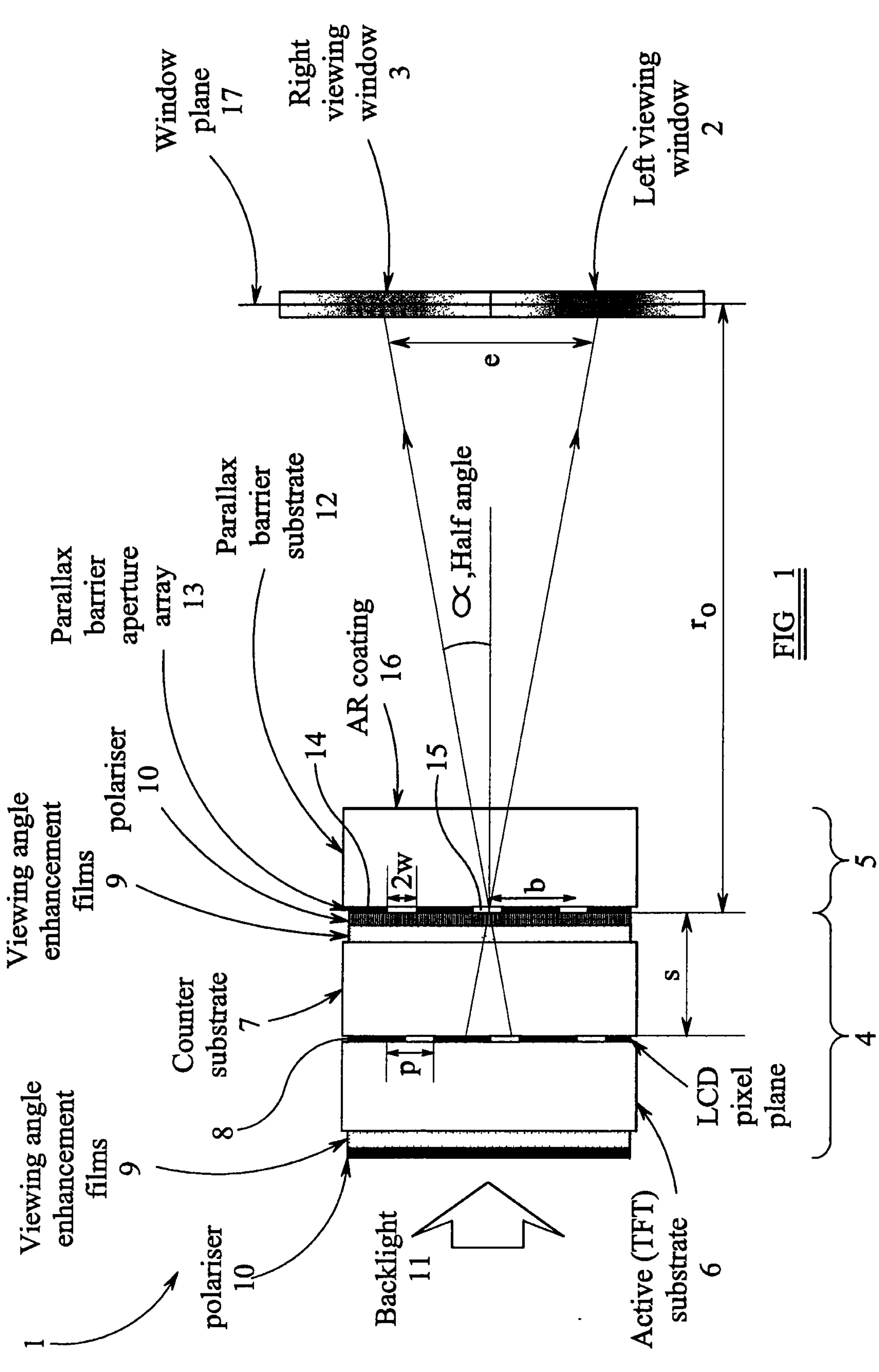

1
polariser
10
Viewing angle
enhancement
films
9
Backlight
11
Active (TFT)
substrate
6
8
p
Counter
substrate
7
LCD
pixel
plane
Viewing angle
enhancement
films
9
polariser
10
Parallax
barrier
aperture
array
13
Parallax
barrier
substrate
12
14
AR coating
16
15
2w
b
s
4
5
∝, Half angle
r_o
e
Window
plane
17
Right
viewing
window
3
Left viewing
window
2

FIG 1

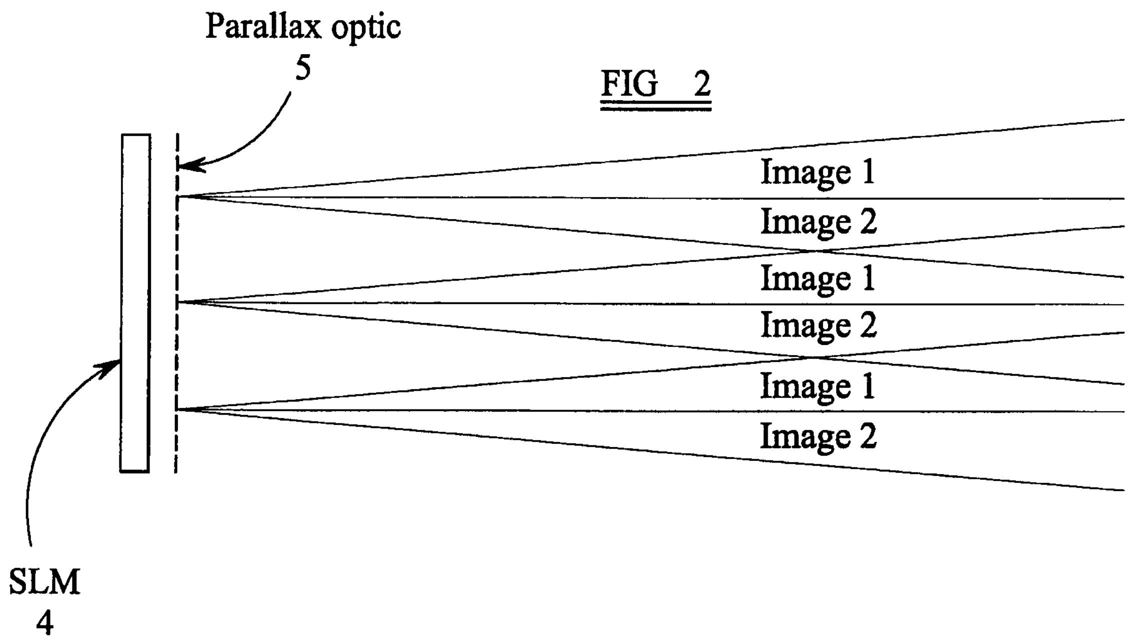

Parallax optic
5
Image 1
Image 2
Image 1
Image 2
Image 1
Image 2
SLM
4

FIG 2

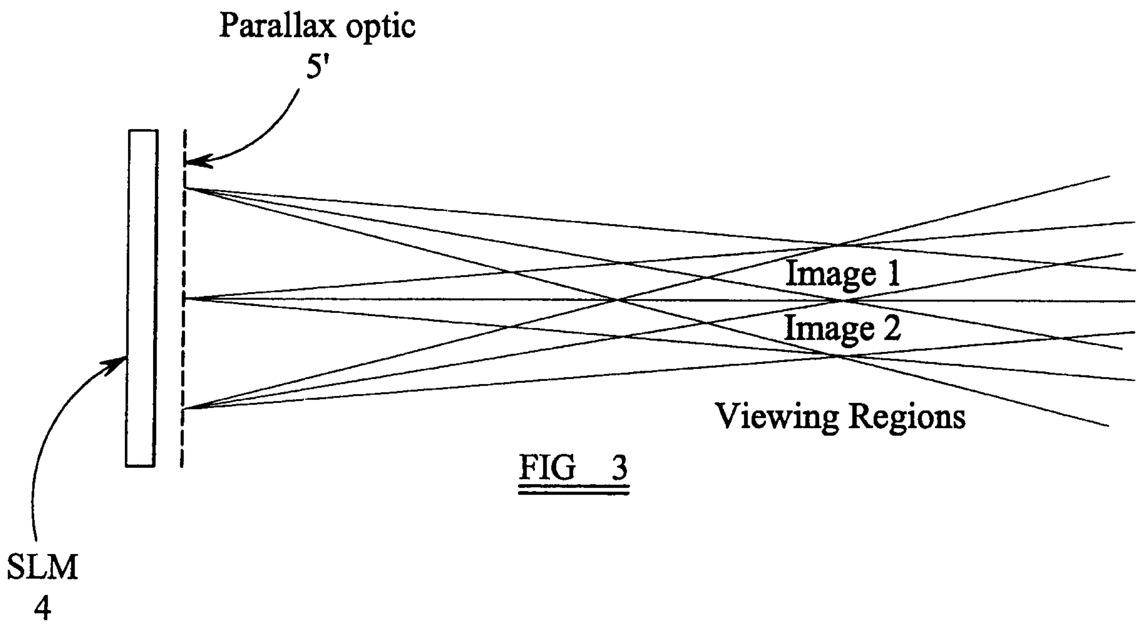

Parallax optic
5'
Image 1
Image 2
Viewing Regions
SLM
4

FIG 3

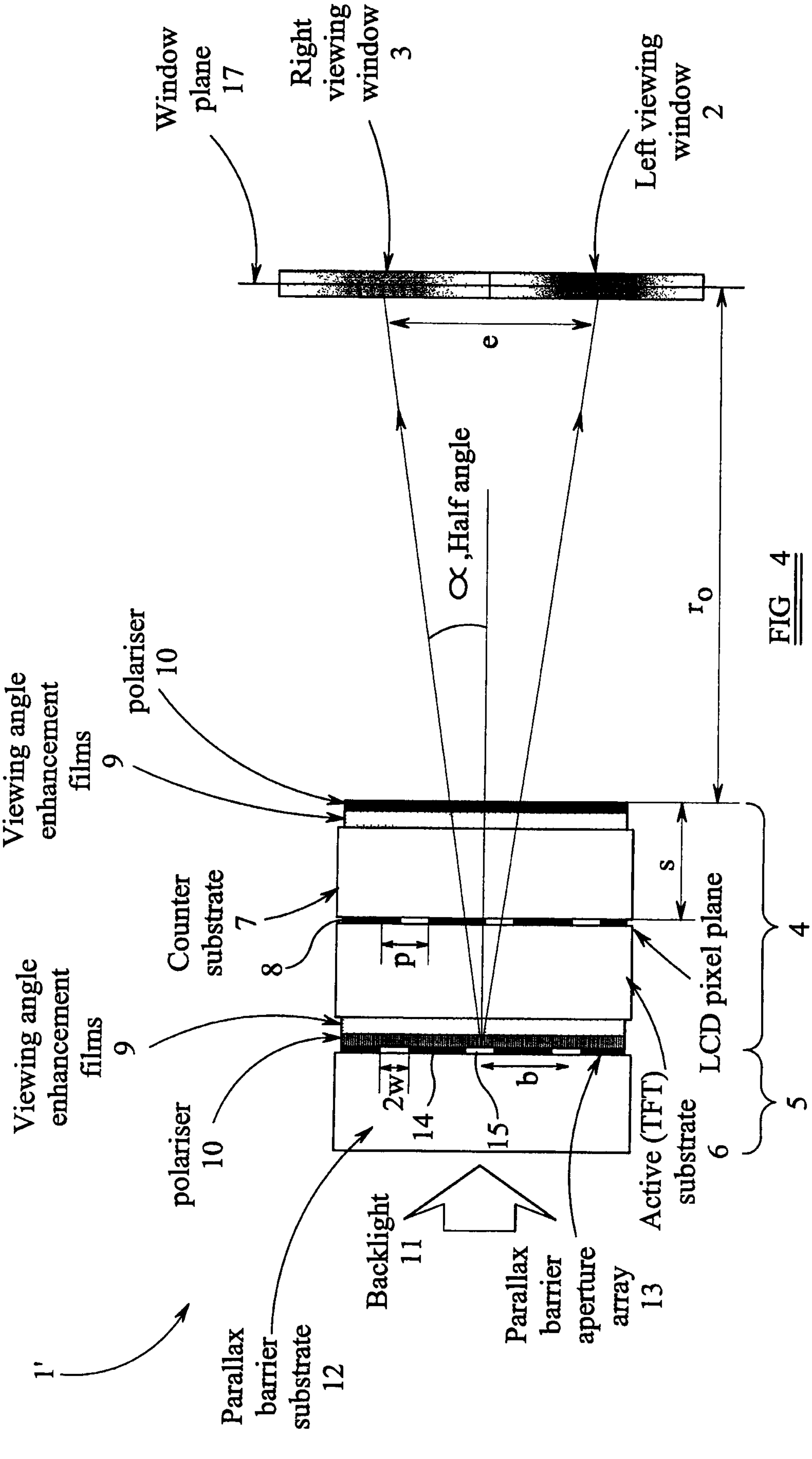

Window plane 17
Right viewing window 3
Left viewing window 2
e
α, Half angle
r_o
polariser 10
Viewing angle enhancement films 9
Counter substrate 7
8
p
s
LCD pixel plane
4
Viewing angle enhancement films 9
polariser 10
2w
14
15
b
Active (TFT) substrate 6
5
Backlight 11
Parallax barrier aperture array 13
Parallax barrier substrate 12
1'

FIG 4

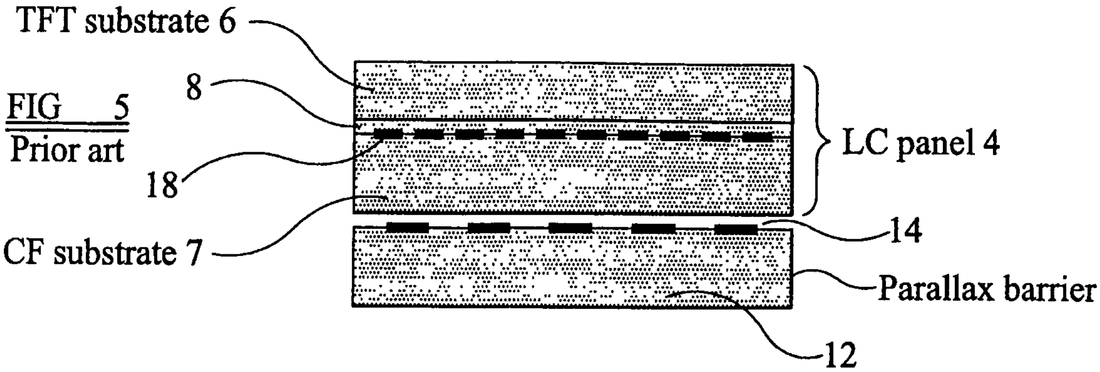


FIG 5
Prior art

Figure 6

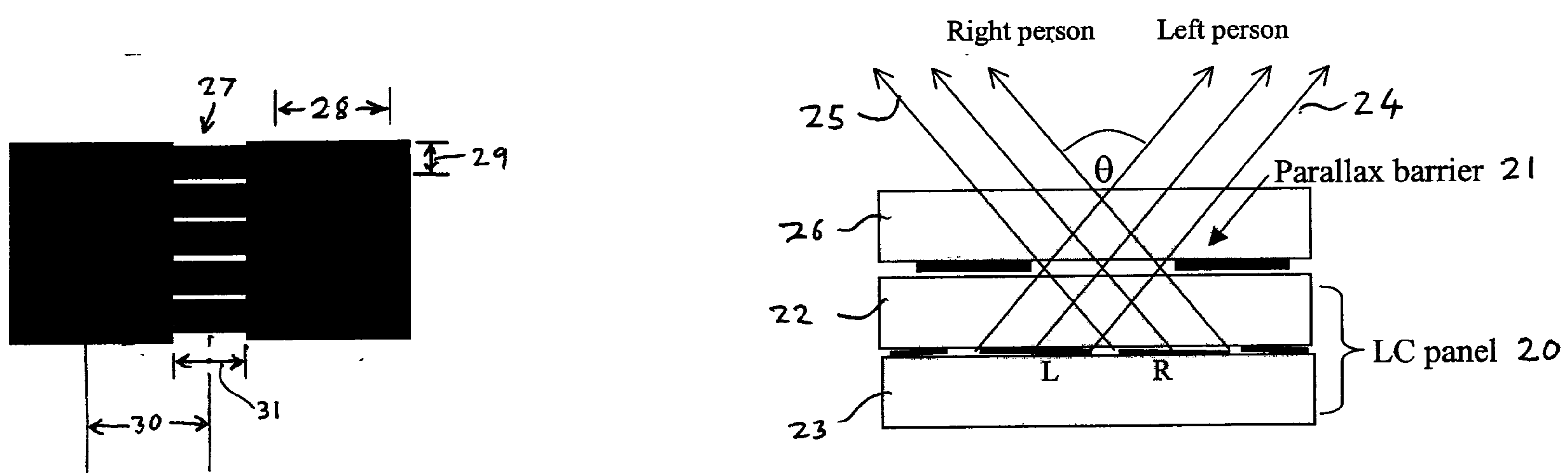

27
28
29
30
31
Right person
Left person
25
24
θ
Parallax barrier 21
26
22
LC panel 20
L
R
23

Fig 7

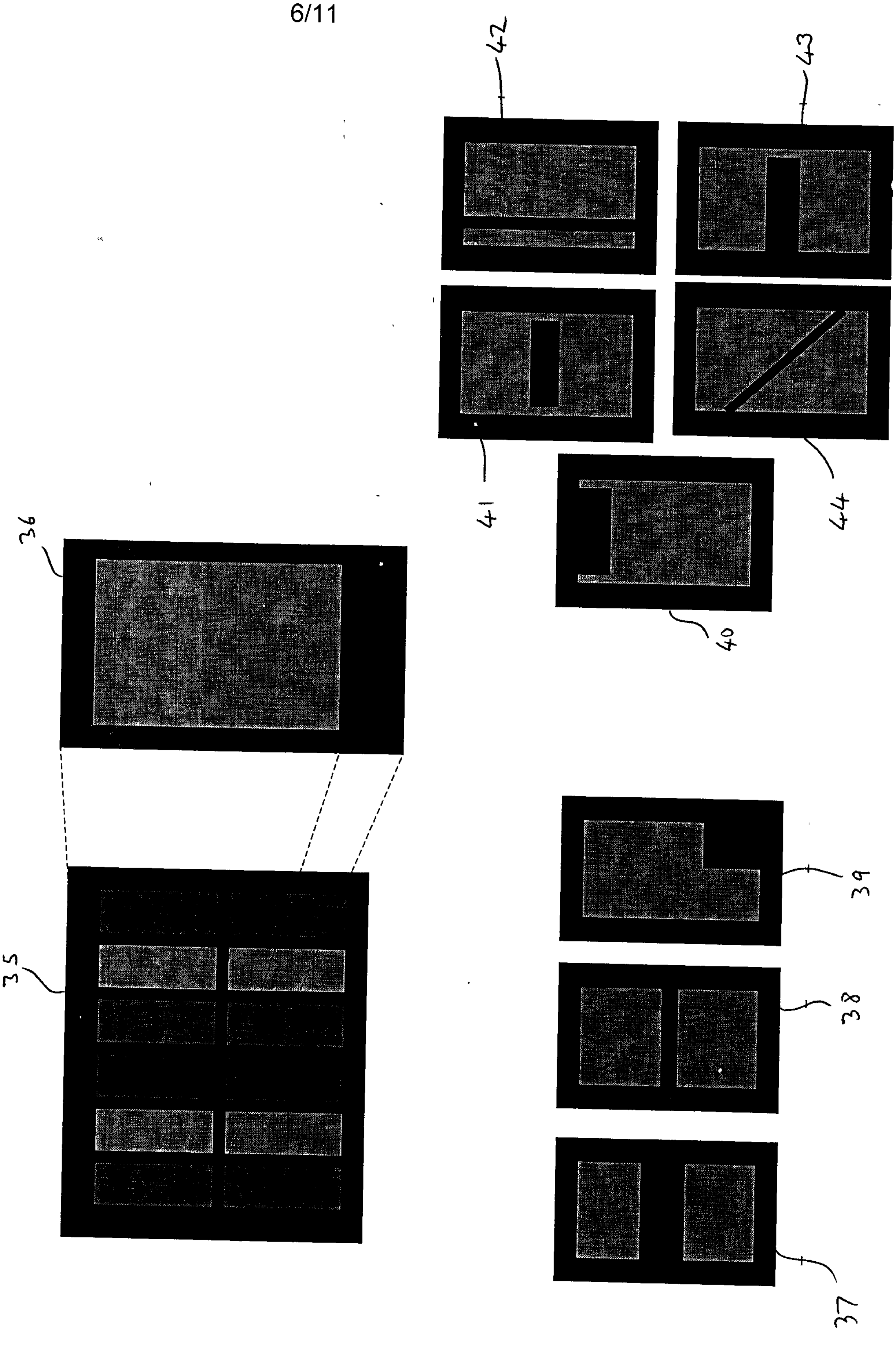


Fig 8

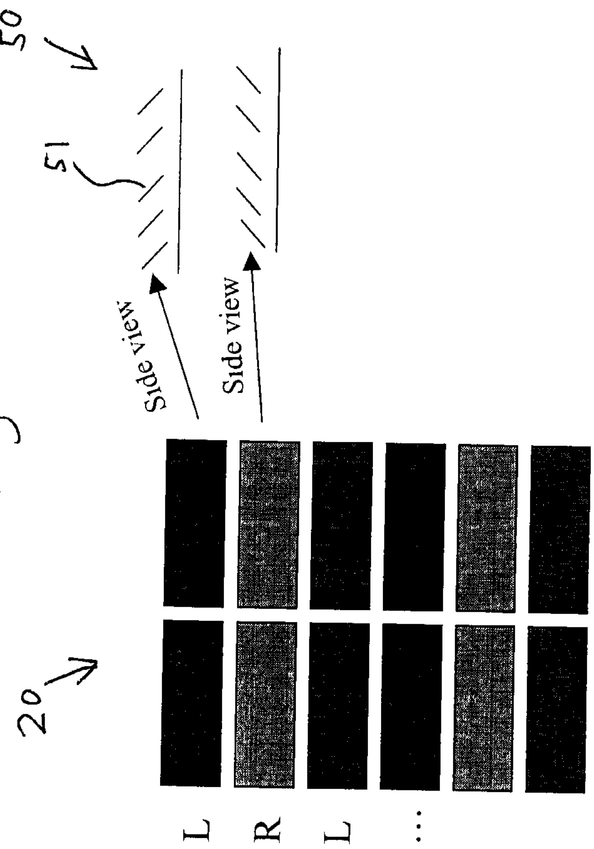
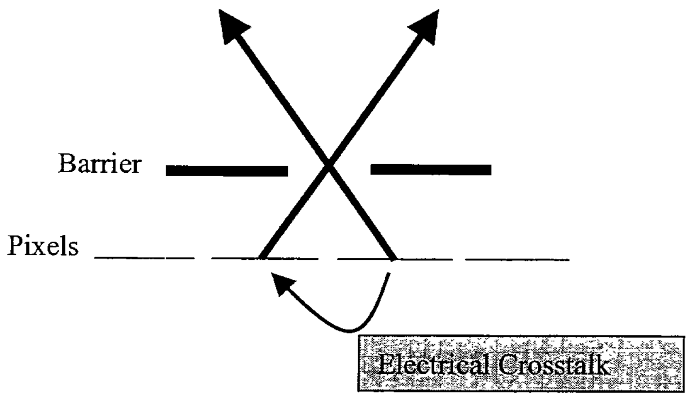


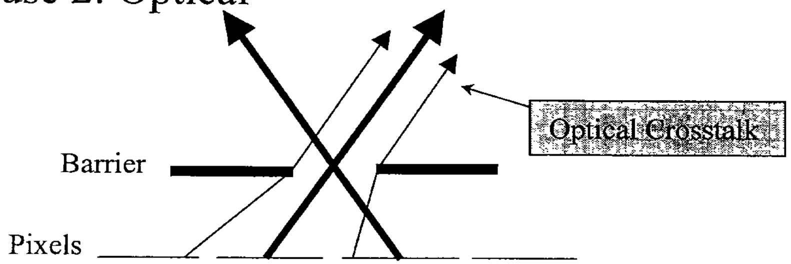
Figure 9

Cause 1: Electrical



• Parasitic capacitance in TFT

Cause 2: Optical



• Mostly diffraction or scattering at the barrier.

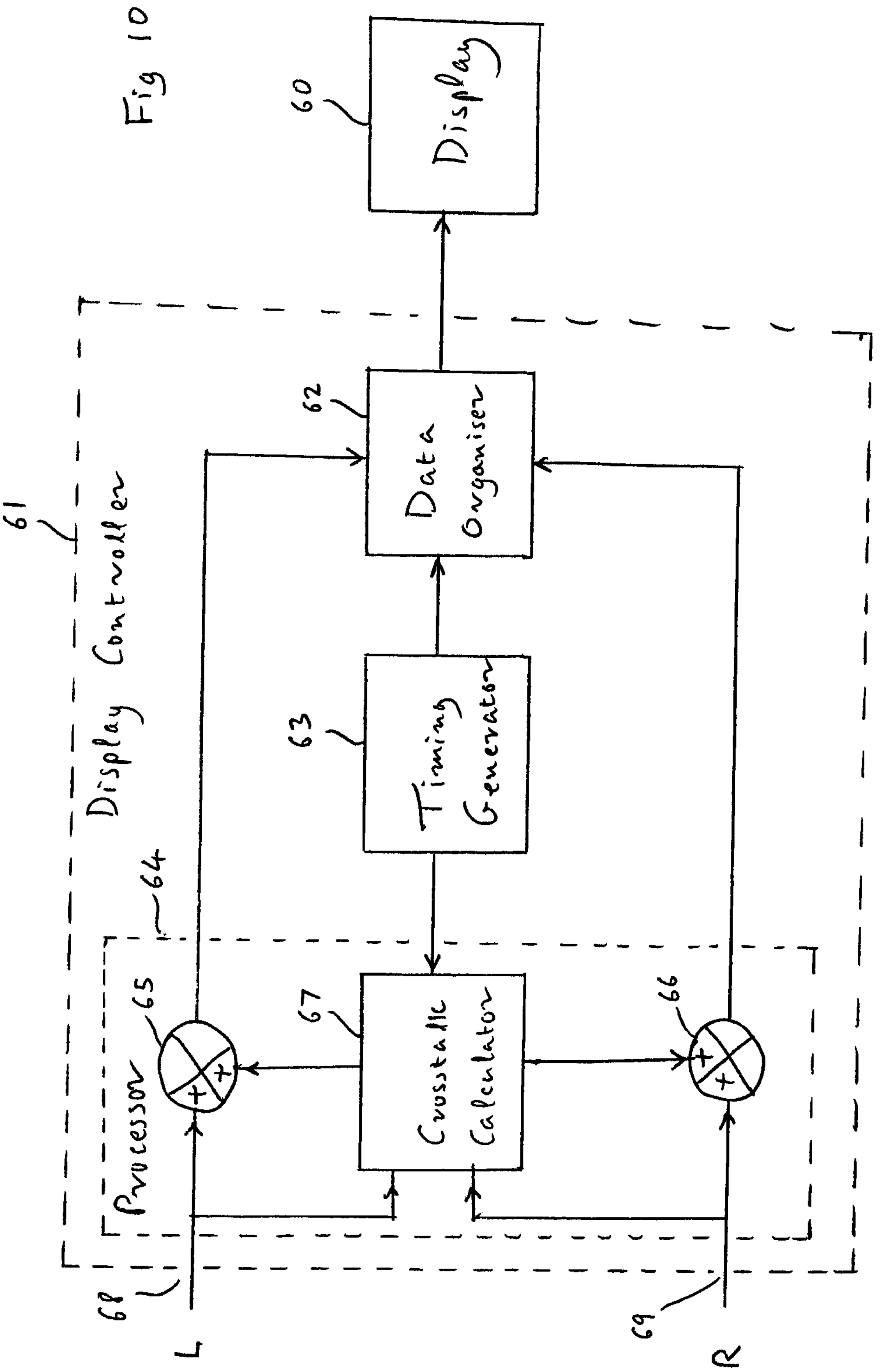
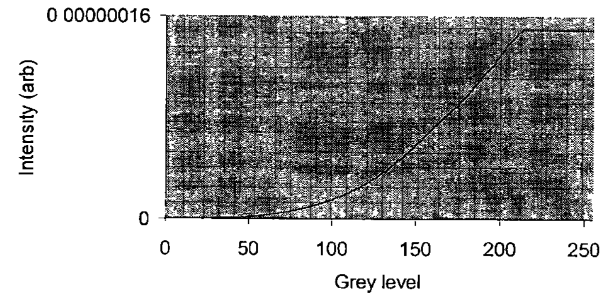

Display
60
Data Organiser
62
Display Controller
61
Timing Generator
63
Processor
64
Crosstalk Calculator
67
65
66
+
+
+
+
L
68
R
69

Fig 10

Fig 11

Typical grey level intensities of an LCD



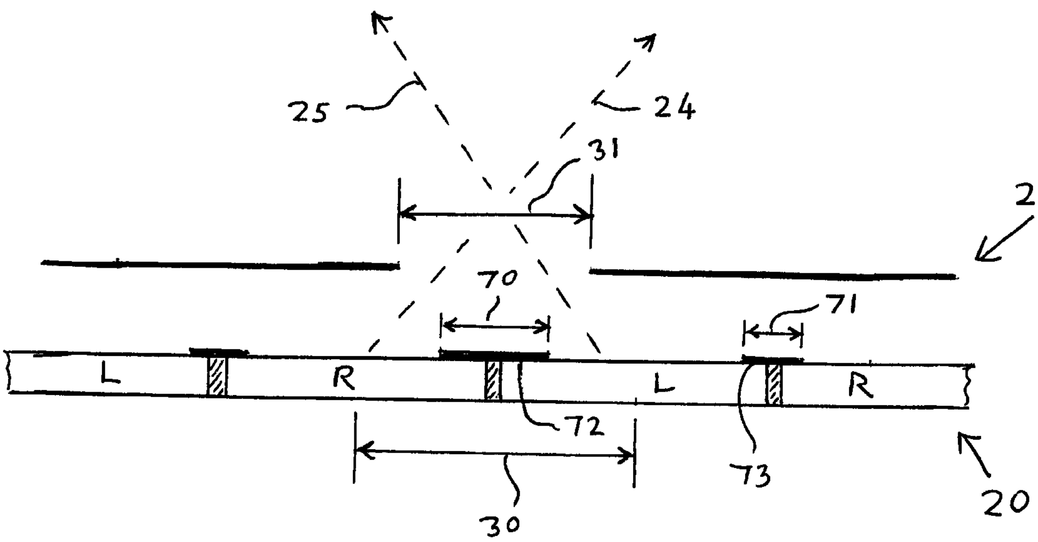


Fig 12

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A Multiple-View Display and Display Controller

The present invention relates to a multiple-view display, which displays two or more images such that each image is visible from a different direction. The present invention also relates to a display controller.

For many years conventional display devices have been designed to be viewed by multiple users simultaneously. The display properties of the display device are made such that viewers can see the same good image quality from different angles with respect to the display. This is effective in applications where many users require the same information from the display – such as, for example, displays of departure information at airports and railway stations. However, there are many applications where it would be desirable for individual users to be able to see different information from the same display. For example, in a motor car the driver may wish to view satellite navigation data while a passenger may wish to view a film. These conflicting needs could be satisfied by providing two separate display devices, but this would take up extra space and would increase the cost. Furthermore, if two separate displays were used in this example it would be possible for the driver to see the passenger's display if the driver moved his or her head, which would be distracting for the driver. As a further example, each player in a computer game for two or more players may wish to view the game from his or her own perspective. This is currently done by each player viewing the game on a separate display screen so that each player sees their own unique perspective on individual screens. However, providing a separate display screen for each player takes up a lot of space and is costly, and is not practical for portable games.

To solve these problems, multiple-view directional displays have been developed. One application of a multiple-view directional display is as a 'dual-view display', which can simultaneously display two or more different images, with each image being visible only in a specific direction – so an observer viewing the display device from one direction will see one image whereas an observer viewing the display device from another, different direction will see a different image. A display that can show different images to two or more users provides a considerable saving in space and cost compared with use of two or more separate displays.

Examples of possible applications of multiple-view directional display devices have been given above, but there are many other applications. For example, they may be used in aeroplanes where each passenger is provided with their own individual in-flight entertainment programmes. Currently each passenger is provided with an individual display device, typically in the back of the seat in the row in front. Using a multiple view directional display could provide considerable savings in cost, space and weight since it would be possible for one display to serve two or more passengers while still allowing each passenger to select their own choice of film.

A further advantage of a multiple-view directional display is the ability to preclude the users from seeing each other's views. This is desirable in applications requiring security such as banking or sales transactions, for example using an automatic teller machine (ATM), as well as in the above example of computer games.

A further application of a multiple view directional display is in producing a three-dimensional display. In normal vision, the two eyes of a human perceive views of the world from different perspectives, owing to their different location within the head. These two perspectives are then used by the brain to assess the distance to the various objects in a scene. In order to build a display which will effectively display a three dimensional image, it is necessary to re-create this situation and supply a so-called "stereoscopic pair" of images, one image to each eye of the observer.

Three dimensional displays are classified into two types depending on the method used to supply the different views to the eyes. A stereoscopic display typically displays both images of a stereoscopic image pair over a wide viewing area. Each of the views is encoded, for instance by colour, polarisation state, or time of display. The user is required to wear a filter system of glasses that separate the views and let each eye see only the view that is intended for it.

An autostereoscopic display displays a right-eye view and a left-eye view in different directions, so that each view is visible only from respective defined regions of space. The region of space in which an image is visible across the whole of the display active area is termed a "viewing window". If the observer is situated such that their left eye is in the viewing window for the left eye view of a stereoscopic pair and their right eye is in the viewing window for the right-eye image of the pair, then a correct view will be seen by each eye of the observer and a three-dimensional image will be perceived. An autostereoscopic display requires no viewing aids to be worn by the observer.

An autostereoscopic display is similar in principle to a dual-view display. However, the two images displayed on an autostereoscopic display are the left-eye and right-eye images of a stereoscopic image pair, and so are not independent from one another. Furthermore, the two images are displayed so as to be visible to a single observer, with one image being visible to each eye of the observer.

For a flat panel autostereoscopic display, the formation of the viewing windows is typically due to a combination of the picture element (or "pixel") structure of the image display unit of the autostereoscopic display and an optical element, generically termed a parallax optic. An example of a parallax optic is a parallax barrier, which is a screen with transmissive regions, often in the form of slits, separated by opaque regions. This screen can be set in front of or behind a spatial light modulator (SLM) having a two-dimensional array of picture elements to produce an autostereoscopic display.

Figure 1 is a plan view of a conventional multiple view directional device, in this case an autostereoscopic display. The directional display 1 consists of a spatial light modulator (SLM) 4 that constitutes an image display device, and a parallax barrier 5. The SLM of Figure 1 is in the form of a liquid crystal display (LCD) device having an active matrix thin film transistor (TFT) substrate 6, a counter-substrate 7, and a liquid crystal layer 8 disposed between the substrate and the counter substrate. The SLM is provided with addressing electrodes (not shown) which define a plurality of independently-addressable picture elements, and is also provided with alignment layers (not shown) for aligning the liquid crystal layer. Viewing angle enhancement films 9 and linear polarisers 10 are provided on the outer surface of each substrate 6, 7. Illumination 11 is supplied from a backlight (not shown).

The parallax barrier 5 comprises a substrate 12 with a parallax barrier aperture array 13 formed on its surface adjacent the SLM 4. The aperture array comprises vertically extending (that is, extending into the plane of the paper in Figure 1) transparent apertures 15 separated by opaque portions 14. An anti-reflection (AR) coating 16 is formed on the opposite surface of the parallax barrier substrate 12 (which forms the output surface of the display 1).

The pixels of the SLM 4 are arranged in rows and columns with the columns extending into the plane of the paper in Figure 1. The pixel pitch (the distance from the centre of one pixel to the centre of an adjacent pixel) in the row or horizontal direction being p. The width of the vertically-extending transmissive slits 15 of the aperture array 13 is 2w and the horizontal pitch of the transmissive slits 15 is b. The plane of the barrier aperture array 13 is spaced from the plane of the liquid crystal layer 8 by a distance s.

In use, the display device 1 forms a left-eye image and a right-eye image, and an observer who positions their head such that their left and right eyes are coincident with the left-eye viewing window 2 and the right-eye viewing window 3 respectively will see a three-dimensional image. The left and right viewing windows 2,3 are formed in a window plane 17 at the desired viewing distance from the display. The window plane is spaced from the plane of the aperture array 13 by a distance r_o. The windows 2,3 are contiguous in the window plane and have a pitch e corresponding to the average separation between the two eyes of a human. The half angle to the centre of each window 10, 11 from the normal axis to the display normal is α_s.

The pitch of the slits 15 in the parallax barrier 5 is chosen to be close to an integer multiple of the pixel pitch of the SLM 4 so that groups of columns of pixels are associated with a specific slit of the parallax barrier. Fig. 1 shows a display device in which two pixel columns of the SLM 4 are associated with each transmissive slit 15 of the parallax barrier.

Figure 2 shows the angular zones of light created from an SLM 4 and parallax barrier 5 where the parallax barrier has a pitch of an exact integer multiple of the pixel column pitch. In this case, the angular zones coming from different locations across the display panel surface intermix and a pure zone of view for image 1 or image 2 (where 'image 1' and 'image 2' denote the two images displayed by the SLM 4) does not exist. In order to address this, the pitch of the parallax barrier is preferably reduced slightly so that it is slightly less than an integer multiple of the pixel column pitch. As a result, the angular zones converge at a pre-defined plane (the "window plane") in front of the display. This effect is illustrated in Figure 3 of the accompanying drawings, which shows the image zones created by an SLM 4 and a modified parallax barrier 5'. The viewing regions, when created in this way, are roughly kite-shaped in plan view.

Figure 4 is a plan view of another conventional multiple view directional display device 1'. This corresponds generally to the display device 1 of Figure 1, except that the parallax barrier 5 is placed behind the SLM 4, so that it is between the backlight and SLM 4. This device may have the advantages that the parallax barrier is less visible to an observer, and that the pixels of the display appear to be closer to the front of the device. Furthermore, although figures 1 and 4 each show a transmissive display device illuminated by a backlight, reflective devices that use ambient light (in bright conditions) are known. In the case of a transflective device, the rear parallax barrier of Figure 4 will absorb none of the ambient lighting. This is an advantage if the display has a 2D mode that uses reflected light.

In the display devices of figures 1 and 4, a parallax barrier is used as the parallax optic. Other types of parallax optic are known. For example, lenticular lens arrays may be used to direct interlaced images in different directions, so as to form a stereoscopic image pair or to form two or more images, each seen in a different direction.

Holographic methods of image splitting are known, but in practice these methods suffer from viewing angle problems, pseudoscopic zones and a lack of easy control of the images.

Another type of parallax optic is a micropolariser display, which uses a polarised directional light source and patterned high precision micropolariser elements aligned with the pixels of the SLM. Such a display offers the potential for high window image quality, a compact device, and the ability to switch between a 2D display mode and a

3D display mode. The dominant requirement when using a micropolariser display as a parallax optic is the need to avoid parallax problems when the micropolariser elements are incorporated into the SLM.

Where a colour display is required, each pixel of the SLM 4 is generally given a filter associated with one of the three primary colours. By controlling groups of three pixels, each with a different colour filter, many visible colours may be produced. In an autostereoscopic display each of the stereoscopic image channels must contain sufficient of the colour filters for a balanced colour output. Many SLMs have the colour filters arranged in vertical columns, owing to ease of manufacture, so that all the pixels in a given column have the same colour filter associated with them. If a parallax optic is disposed on such an SLM with three pixel columns associated with each slit or lenslet of the parallax optic, then each viewing region will see pixels of one colour only. Care must be taken with the colour filter layout to avoid this situation. Further details of suitable colour filter layouts are given in EP-A-0 752 610.

The function of the parallax optic in a directional display device such as those shown in figures 1 and 4 is to restrict light transmitted through the pixels of the SLM 4 to certain output angles. This restriction defines the angle of view of each of the pixel columns behind a given element of the parallax optic (such as for example a transmissive slit). The angular range of view of each pixel is determined by the pixel pitch p, the separation s between the plane of the pixels and the plane of the parallax optic, and the refractive index n of the material between the plane of the pixels and the plane of the parallax optic (which in the display of Figure 1 is the substrate 7). H Yamamoto et al. show, in “Optimum parameters and viewing areas of stereoscopic full-colour LED displays using parallax barrier”, IEICE Trans. Electron., vol. E83-C, No. 10, p1632 (2000), that the angle of separation between images in an autostereoscopic display depends on the distance between the display pixels and the parallax barrier.

The half-angle α of Figure 1 or 4 is given by:

$$\sin\alpha = n\sin\left(\arctan\left(\frac{p}{2s}\right)\right) \qquad (1)$$

One problem with many existing multiple view directional displays is that the angular separation between the two images is too low. In principle, the angle 2α between viewing windows may be increased by increasing the pixel pitch p, decreasing the separation between the parallax optic and the pixels s, or by increasing the refractive index of the substrate n.

In general, however, the pixel pitch is typically defined by the required resolution specification of the display device and therefore cannot be changed.

It is not always practical or cost effective significantly to change the refractive index of the substrates, which are normally made of glass.

Other attempts at increasing the angular separation between the viewing windows of a multiple-view directional display device have attempted to reduce the separation between the parallax optic and the plane of the pixels of the SLM. However, this has been difficult as will be explained with respect to Figure 5, which is a schematic block view of the display device 1 of Figure 1 with an LCD as the SLM 4.

The LCD panel which forms the SLM 4 is made from two glass substrates. The substrate 6 carries TFT switching elements for addressing the pixels of the SLM, and is therefore known as a "TFT substrate". It will in general also carry other layers for, for example, aligning the liquid crystal layer 8 and allowing electrical switching of the liquid crystal layer. On the other substrate 7 (corresponding to the counter substrate of Figure 1) colour filters 18 are formed, together with other layers for, for example, aligning the liquid crystal layer. The counter substrate 7 is therefore generally known as a "colour filter substrate" or CF substrate. The LCD panel is formed by placing the colour filter substrate opposite to the TFT substrate, and sandwiching the liquid crystal layer 8 between the two substrates. In previous directional displays the parallax optic has been adhered to the completed LCD panel as shown in figure 5. The distance between the LCD pixels and the parallax optic is determined primarily by the thickness of the CF substrate of the LCD. Reducing the thickness of the CF substrate will reduce the distance between the LCD pixels and the parallax optic, but will make the substrate correspondingly weaker. A realistic minimum for LC substrate thickness is about 0.5mm, but the pixel-to-parallax optic separation would still be too large for many applications if a parallax optic were adhered to a substrate of this thickness.

EP 0953962 discloses a technique for providing correction for crosstalk so as to reduce its visibility. Such a technique is effective for autostereoscopic 3D displays but may not be sufficient for multiple view displays where the different images are viewed by different observers.

EP 0822441 discloses an autostereoscopic 3D display using a parallax barrier as the parallax optic and, in particular, discloses a technique for reducing the crosstalk caused by diffraction. For example, pixels having "soft" edges are disclosed in order to reduce diffraction and hence crosstalk.

US 5850269 discloses another 3D autostereoscopic display which uses a lenticular lens array as the parallax optic. This arrangement is specifically concerned with preventing undesirable colour artefacts from occurring.

According to a first aspect of the invention, there is provided a multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing by respective different viewers in respective different directions with respect to the display, the pixels being elongate substantially in the horizontal direction of the designed image orientation on the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.

The pixels may be rectangular with major axes extending substantially in the horizontal direction.

The parallax optic may comprise a parallax barrier comprising a plurality of slits oriented in a vertical direction of the designed image orientation on the display.

The pixels may be spaced apart horizontally with a constant horizontal pitch and may have a horizontal aperture between 40% and 90% of the horizontal pitch. The horizontal aperture may be substantially equal to 70% of the horizontal pitch.

The pixels may have a vertical aperture substantially equal to one third of the horizontal aperture thereof.

The horizontal width of the slits may be greater than or equal to the horizontal pixel aperture.

The horizontal width of the slits may be substantially equal to the horizontal pixel aperture.

The parallax barrier may be disablable to provide a single view mode of operation and the horizontal width of the slits may be less than the horizontal pixel aperture.

The display may comprise a horizontally striped colour filter.

According to a second aspect of the invention, there is provided use of pixels which are elongate substantially in the horizontal direction of a designed image orientation on a display to reduce crosstalk. In a multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing in respective different directions with respect to the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.

The images may be for viewing by respective different viewers.

The parallax optic may comprise a parallax barrier comprising a plurality of slits oriented in a vertical direction of the designed image orientation on the display.

The pixels may be rectangular with major axes extending substantially in the horizontal direction.

The pixels may be spaced apart horizontally with a constant horizontal pitch and may have a horizontal aperture between 40% and 90% of the horizontal pitch. The horizontal aperture may be substantially equal to 70% of the horizontal pitch.

The pixels may have a vertical aperture substantially equal to one third of the horizontal aperture thereof.

The horizontal width of the slits may be greater than or equal to the horizontal pixel aperture.

The horizontal width of the slits may be substantially equal to the horizontal pixel aperture.

The parallax barrier may be disablable to provide a single view mode of operation and the horizontal width of the slits may be less than the horizontal pixel aperture.

The display may comprise a horizontally striped colour filter.

According to a third aspect of the invention, there is provided a multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing by respective different viewers in respective different directions with respect to the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions, the modulator further comprising a black mask defining pixel apertures of the pixels and having portions between pixel apertures, which are horizontally adjacent in the horizontal direction of the designed image orientation on the display, which portions are of at least two different widths.

The parallax optic may comprise a plurality of parallax elements, each of which cooperates with a respective group of pixels. The width of each portion of the black mask between pixels of the same group may be greater than the width of each portion of the black mask between pixels of different groups. As an alternative, the width of each portion of the black mask between pixels of the same group may be less than the width of each portion of the black mask between pixels of different groups.

The width of each portion of the black mask between pixels of the same group may be between substantially 32% and substantially 48% of the horizontal pixel pitch.

The width of each portion of the black mask between pixels of different groups may be between substantially 16% and substantially 24% of the horizontal pixel pitch.

The parallax optic may comprise a parallax barrier comprising a plurality of slits oriented in a vertical direction of the designed image orientation on the display. The horizontal width of the slits may be substantially equal to the horizontal pixel aperture.

According to a fourth aspect of the invention, there is provided a multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing by respective different viewers in respective different directions with respect to the display, each pixel having no portion with a minimum width, in the horizontal direction of the designed image orientation on the display, less than substantially half the horizontal pixel aperture; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.
The parallax optic may comprise a parallax barrier.

Each pixel may have a substantially rectangular aperture.

Each pixel may have an aperture comprising a plurality of substantially rectangular sub-apertures.

According to a fifth aspect of the invention, there is provided a multiple view display comprising: a spatial light modulator comprising a plurality of rows of pixels arranged as sets, each row extending in the horizontal direction of the designed image orientation on the display, the sets of rows being arranged to display interlaced horizontal strips of a plurality of images for viewing by respective different viewers in respective different directions with respect to the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.

Each set may comprise one row.

The parallax optic may comprise a plurality of horizontal rows of microlouvres orientated in the different directions, each row cooperating with a respective set.

The display may comprise a horizontally striped colour filter.

The display may comprise a controller for supplying to the modulator pixel data in a form suitable for interlacing the images.

The modulator may comprise a light valve, such as a liquid crystal device.

The plurality of images may comprise two images.

According to a sixth aspect of the invention, there is provided a display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor arranged to add to a pixel value of each pixel of each image to be displayed a predetermined grey level to form a sum and to subtract from each sum an optical crosstalk correction value which is a function of: the value of at least one other pixel of another of the images to be displayed; and a mapping relating pixel intensity to grey level for the display.

The predetermined grey level may be the same for all pixels. The predetermined grey level may represent a maximum possible crosstalk contribution.

The at least one other pixel may comprise one other pixel. The other pixel may be of a same colour.

The crosstalk correction value may also be a function of the pixel value to be corrected.

According to a seventh aspect of the invention, there is provided a display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor arranged to add to each pixel value of at least some pixels of the display an electrical crosstalk correction value which is a function of electrical crosstalk within the display.

The function may comprise a function of the pixel value to be corrected and the value of at least one other pixel. The at least one other pixel may comprise an adjacent pixel.

The function may further comprise a function of a mapping relating pixel intensity to grey level for the display.

According to an eighth aspect of the invention, there is provided a display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor arranged to add to at least one of the images a masking image for masking crosstalk between images.

The processor may be arranged to add the same masking image to each of the images.

The masking image may comprise noise. As an alternative, the masking image may comprise random text.

The masking image may be a static image. As an alternative, the masking image may be a changing image.

The masking image may comprise a grey level.

The processor may be arranged to add the grey level when the at least one image is substantially black.

The masking image may have a maximum brightness substantially equal to 5% of the maximum display brightness.

The masking image may have a maximum brightness equal to or greater than 10 times the maximum expected crosstalk brightness.

According to a ninth aspect of the invention, there is provided a display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor for reducing image brightness in response to a signal indicative of reduced ambient light.

The controller may comprise a light sensor for providing the signal.

The controller may be for a display installed in a vehicle and may comprise an input for receiving the signal which is indicative of illumination of vehicle headlamps.

The plurality of images may comprise two images.

A controller according to any of the sixth to ninth aspects of the invention may be combined with a display according to any of the first to third aspects of the invention.

It is thus possible to provide arrangements which result in reduced crosstalk between images viewed on multiple view displays.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic plan view of a conventional autostereoscopic display device;

Figure 2 is a schematic illustration of viewing windows provided by a conventional multiple view display device;

Figure 3 is a schematic plan view of viewing windows produced by another conventional multiple view directional display device;

Figure 4 is a schematic plan view of another conventional autostereoscopic display device;

Figure 5 is a schematic plan view showing the principal components of a conventional multiple view directional display device;

Figure 6 shows diagrammatic front and cross-sectional views of a multiple view display constituting an embodiment of the invention;

Figure 7 is a diagram illustrating desirable and undesirable pixel aperture shapes;

Figure 8 is a diagram illustrating a multiple view display constituting an embodiment of the invention;

Figure 9 is a diagram illustrating causes of crosstalk in a multiple view display;

Figure 10 is a schematic diagram of a display controller constituting an embodiment of the invention;

Figure 11 is a graph illustrating a mapping between display pixel intensity and grey level; and

Figure 12 shows a diagrammatic cross-sectional view of a multiple view display constituting an embodiment of the invention.

Figure 6 illustrates diagrammatically front and cross-sectional views of a multiple view display for simultaneously displaying left and right images so that these can only be seen by viewers from directions to the left and right of the normal to the display. The display comprises a spatial light modulator in the form of a transmissive liquid crystal (LC) panel 20 with a backlight (not shown) and a front parallax barrier (21). The LC panel 20 comprises substrates 22 and 23 between which are formed pixels L and R for displaying spatially multiplexed or interlaced left and right views for viewing in the directions indicated by the arrows 24 and 25, respectively. The angle between the viewing directions is indicated at θ. The parallax barrier 21 is formed on a substrate 26 so that the pixel plane of the panel 20 is disposed between the substrates 22 and 23 and the barrier plane is disposed between the substrates 22 and 26.

As shown in the front view in Figure 6, the pixels are arranged as rows and columns with adjacent columns of pixels displaying interlaced vertical strips of the two images to be displayed. Each pair of columns of pixels cooperates with a respective slit 27 of the barrier 21, which substantially restricts the light modulated by the pixel columns so that the correct images are seen by each viewer whereas the incorrect image is not substantially visible to each viewer.

Each of the pixels is rectangular with its major axis extending horizontally when referred to the intended or designed orientation of images displayed by the pixels of the panel 20. Each pixel has a horizontal aperture 28 which is substantially three times the vertical aperture 29 thereof. In this respect, the horizontal and vertical apertures are defined as the maximum width and the maximum height of the pixel in the horizontal and vertical directions, respectively. The pixels are arranged as a regular rectangular array with a horizontal pitch 30 such that the horizontal aperture 28 is between 40% and 90% of the horizontal pitch 30. In a preferred embodiment, the horizontal aperture 28 is 70% of the horizontal pixel pitch in order to give a good compromise between brightness and viewer freedom of movement while producing relatively low levels of crosstalk between images from diffraction and scattering within the display.

The width 31 of each slit 27 of the barrier 21 may be substantially equal to the horizontal aperture of the pixels in order to provide good brightness of display. For improved, i.e. lower, crosstalk, the slit width 31 may be made wider and the pixel horizontal aperture may be made smaller.

In embodiments where the parallax barrier 21 can be disabled so as to provide a single view mode of operation, higher brightness may be achieved by making the pixel horizontal aperture 28 larger than the slit width 31.

As indicated by the shading in the front view of Figure 6, the display includes a horizontally striped colour filter so that the pixels are arranged as rows with pixels of each row being of the same colour and with red, green and blue rows repeating cyclically in the vertical direction. A composite colour pixel is formed by triplets of vertically arranged red, green and blue pixels.

Figure 7 illustrates another type of LC panel in which the pixels are elongate and extend in the vertical direction of the designed image orientation on the display. An example of part of a panel is shown at 35 and the "ideal" rectangular pixel shape is shown at 36. Such a pixel shape 36 has no features in the horizontal direction of small width so that the greater crosstalk which would be produced by horizontal diffraction from such smaller features is absent.

Figure 7 illustrates three other pixel shapes at 37, 38 and 39. The shapes shown at 37 and 38 have constant width and are made up of two separate rectangular sub-apertures so that there are no "thin" features to contribute to horizontal diffraction. The shape shown at 39 comprises two sub-apertures of rectangular shape contiguous with each other such that the minimum width of any part of the pixel is not less than half the horizontal aperture of the pixel. Such a pixel shape again provides relatively low horizontal diffraction. Figure 7 also illustrates pixel shapes at 40 to 44, all of which have relatively thin vertical lines or regions which produce relatively high horizontal diffraction. Shapes of this type are therefore to be avoided in order to reduce horizontal diffraction and hence avoid unnecessary crosstalk.

Figure 8 illustrates diagrammatically a liquid crystal panel 20 cooperating with a parallax optic 50 to form a multiple view display. The pixels of the panel 20 are arranged in much the same way as shown in Figure 6 but are allocated differently to the left and right views. In particular, each row (rather than each column) of pixels displays a horizontal slice or strip of one of the images to be displayed with the rows displaying left and right strips alternating with each other vertically. The panel 20 includes a colour filter also of the type illustrated in Figure 6 with horizontal stripes of red, green and blue repeating cyclically. Figure 8 shows adjacent rows of pixels displaying different views but the pixels may be arranged as adjacent sets of rows with each set comprising more than one row and displaying a horizontal strip of one of the views.

The parallax optic 50 in the display of Figure 8 is of a microlouvre type and comprises rows of microlouvres, each row of which overlays and cooperates with a respective row (or set of rows) of the pixels of the panel 20. The microlouvres resemble miniature Venetian blinds with the louvres being oriented in the same direction in each row and with the louvres in adjacent rows being oriented in different directions so as substantially to restrict the transmission of light from the panel 20 in the correct direction towards the left or right viewer. The viewing directions are thus parallel to the planes of the individual louvres, such as 51. Microlouvre arrangements of this type are known and will not be described further.

As a possible alternative, the parallax optic 50 shown in Figure 8 may be replaced by a holographic element performing substantially the same function. In fact, the parallax optics in the previously described embodiments may also be replaced by holographic elements.

Figure 9 illustrates two causes of crosstalk between images at viewing locations in multiple view displays. Cause 1 shown at the left of Figure 9 results from electrical crosstalk, which is a small effect which may occur between pixels of an LC panel. This may arise, for example, because of parasitic capacitance in the thin film transistors (TFT's) of driver circuitry of the panel. The behaviour of electrical crosstalk is relatively complex. For example, electrical crosstalk may occur in only one "direction" so that crosstalk from one pixel might only affect a pixel to one side (to the left as shown in Figure 9). Also, the magnitude of electrical crosstalk may depend on the data value supplied to the affected pixel and on the data value supplied to the pixel causing crosstalk.

Cause 2 illustrated at the right in Figure 9 results from optical crosstalk. This can result from imperfections in the optical elements of the display but can also arise from intrinsic causes such as diffraction and scattering at a parallax barrier. A known technique for correcting for optical crosstalk is disclosed in EP 0953962, the contents of which are incorporated herein by reference. This technique is described in the context of autostereoscopic 3D displays. However, multiple view displays require very low levels of crosstalk, preferably lower than in autostereoscopic displays, and it is possible to improve the correction for optical crosstalk as described hereinafter.

Figure 10 illustrates a display 60, for example of any of the types described hereinbefore, and a display controller 61 which is capable of providing electrical and/or optical crosstalk correction. The controller 61 comprises a data organiser 62 controlled by a timing generator 63 and arranged to order the analogue or digital pixel values into the correct temporal order for refreshing the display 60. The data organiser 62 and the timing generator 63 may be of any suitable type, for example of known type for supplying pixel data in the correct order to multiple view displays.

The controller 61 further comprises a processor 64 which performs crosstalk correction. The processor comprises summers 65 and 66 and a crosstalk calculator 67.

The display controller 61 and the display 60 are arranged to provide dual view operation so that two viewers may view mutually independent images which are simultaneously displayed by the display 60. Left (L) and right (R) image data are supplied to inputs 68 and 69 of the controller 61. The left and right image data are supplied to first inputs of the summers 65 and 66, respectively, and to respective inputs of the crosstalk calculator 67. The crosstalk calculator 67 calculates a crosstalk correction value for each image and supplies these values to second inputs of the summers 65 and 66. The crosstalk calculator 67 receives timing signals from the timing generator 63.

The outputs of the summers 65 and 66 are supplied to the data organiser 62, which organises the individual pixel data into the correct order for the display 60. For example, in the case where the left and right images are displayed as interlaced vertical strips one pixel wide by the display 60, the data organiser 62 supplies pixel data alternately from the summers 65 and 66 and, if necessary, discards pixel data so that each horizontal line of pixel data matches the horizontal resolution of the display 60.

In order to correct for electrical crosstalk, the crosstalk calculator 67 calculates correction values based on the pixel value of each pixel affected by electrical crosstalk and on the pixel value of each pixel contributing to the crosstalk of the affected pixel. Further, the crosstalk correction calculated by the calculator 67 also depends on the mapping between pixel intensity and grey level so that the amount by which the pixel grey level needs to be changed can be calculated in order to compensate more accurately for the crosstalk. Figure 11 illustrates an example of such a mapping with intensity in arbitrary units being plotted against grey level represented from 0 to 255. The crosstalk correction values are therefore functions of the affected pixel data level, the affecting pixel data level and the mapping between pixel intensity and grey level.

Crosstalk as a function of the affected and affecting pixel level may be determined experimentally. In the case where the pixels have 256 grey levels (including black), it would be necessary to perform 255 x 255 measurements in order to determine the mapping for every possible combination of grey levels. However, a reduced number of measurements may be made and approximations such as interpolations may then be performed so as to reduce the burden of acquiring data representing the mapping.

It may be necessary or desirable to perform measurements to determine the mapping between pixel intensity and grey level for displays from each production line or possibly even for each individual display. Conversely, if the production processes are sufficiently consistent, it may only be necessary to perform measurements to determine the mapping for one example of the display 60.

Alternatively or additionally, the processor 64 may provide compensation for optical crosstalk. For example, in a typical multiple view display 60, optical crosstalk may be determined by the calculator 67 as a function of the pixel intensity of one or more adjacent pixels displaying a different image (or one or more adjacent pixels of the same colour as the affected pixel displaying a different image), the "level" of optical crosstalk (for example, the amount of optical diffraction and scattering), and the mapping between pixel intensity and grey level. By taking into account the mapping between pixel intensity and grey level, it is possible to improve the accuracy of correction, for example compared with an assumption that the mapping is linear. As shown in Figure 11, the actual mapping is significantly non-linear so that correction is improved by the present technique.

In order to reduce crosstalk, the crosstalk calculator 67 determines the correction value required for each image and subtracts this from a predetermined constant grey level for all pixels. The result is then added to the images in the summers 65 and 66.

As an alternative or an addition to the crosstalk calculations described hereinbefore, the crosstalk calculator 67 adds a faint predetermined masking image such as noise or random text. The addition of such a masking image makes the crosstalk more difficult to interpret as a meaningful image and therefore reduces the crosstalk perceived by the viewers.

The masking image may be a static or unchanging image. Alternatively, the masking image may be one which changes with time if this is more appropriate to mask the crosstalk. For example, a changing image may be more appropriate to provide masking in the case of a non-static displayed image or images.

The level of the masking image is chosen so as to be just sufficient in order to make the crosstalk imperceptible. For example, the masking image may have a maximum brightness which is an order of magnitude higher than the maximum expected crosstalk brightness. For example, in the case of 0.4% crosstalk, a masking image having a maximum level which is about 5% of the maximum brightness of the display has been found to be effective.

Alternatively or additionally, the visibility of crosstalk may be reduced by adding a fixed intensity to the individual images. In particular, when either image is black, the visibility of crosstalk is higher because of the higher sensitivity of human vision to low level images caused by crosstalk. By adding a low level fixed intensity, particularly where an image is currently black, it is possible to obscure the crosstalk by moving it to a grey level range where human vision is less sensitive to the variations in grey level caused by crosstalk.

Such an arrangement requires relatively little image processing power and is therefore simple and cheap to implement. Although this technique is particularly suited to the situation where grey is added to a black screen, it may also be applied to non-black images and results in a small but generally acceptable reduction in contrast ratio.

Alternatively or additionally, the visibility of crosstalk may be reduced by reducing the brightness of the display. For example, crosstalk (such as that visible on a black image) may be particularly visible when the ambient lighting level is low, for example at night when a display is used in a vehicle. By reducing the brightness of the display, such as by dimming a backlight or by means of image processing, the reduced brightness of crosstalk is less visible. In order to control this, a sensor such as a photodiode may be used to sense the ambient lighting intensity and to control dimming of the display. Alternatively, the ambient lighting conditions may be inferred from other parameters. For example, where the display is installed in a vehicle such as a car, the display may be arranged to be dimmed when the vehicle headlights are switched on.

Figure 12 illustrates another multiple view display comprising an LC panel 20 cooperating with a parallax barrier 21 to allow two viewers to view independent images in the viewing directions 24 and 25. The display is illustrated for dual view purposes with left (L) and right (R) image pixels arranged as columns so that the images are displayed on the panel 20 as interlaced vertical strips one pixel wide. The pixels have a horizontal pitch indicated at 30. The barrier slits have a width indicated at 31 which is substantially equal to the horizontal pixel aperture.

The LC panel 20 includes a black mask with portions such as 72 and 73 defining the horizontal apertures of the pixels. Each barrier slit is associated with two columns of pixels (for a dual view display) with the portion 72 of the black mask defining and being disposed between the apertures of the associated pixel columns. The black mask portions such as 73 define the other edges of the horizontal pixel apertures for horizontally adjacent pixels associated with different slits of the parallax barrier 21.

The horizontal width 70 of the black mask portions such as 72 is between approximately 32% and 48% of the pixel pitch 30 whereas the width 71 of the black mask portions 73 is between approximately 16% and 24% of the pixel pitch 30. In a typical example, the width 31 of the barrier slits is approximately 70% of the pixel pitch 30, the width 70 of the portions 72 of the black mask is substantially 40% of the pixel pitch 30 and the width 71 of the black mask portions 73 is substantially 20% of the pixel pitch 30. The slit width 31 is therefore substantially equal to the horizontal aperture of the pixels.

Although the embodiment shown in Figure 12 is such that the width 70 of the black mask portions 72 is greater than the width 71 of the black mask portions 73, it is possible in alternative embodiments for the width 71 to be greater than the width 70. For example, this may be used where secondary lobes become troublesome. Such lobes result from light from a pixel being transmitted through a barrier slit associated with other pixels.

CLAIMS:

1. A multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing by respective different viewers in respective different directions with respect to the display, the pixels being elongate substantially in the horizontal direction of the designed image orientation on the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.

2. A display as claimed in claim 1, in which the parallax optic comprises a parallax barrier comprising a plurality of slits oriented in a vertical direction of the designed image orientation on the display.

3. A display as claimed in claim 1 or 2, in which the pixels are rectangular with major axes extending substantially in the horizontal direction.

4. A display as claimed in any one of the preceding claims, in which the pixels are spaced apart horizontally with a constant horizontal pitch and have a horizontal aperture between 40% and 90% of the horizontal pitch.

5. A display as claimed in claim 4, in which the horizontal aperture is substantially equal to 70% of the horizontal pitch.

6. A display as claimed in any one of the preceding claims, in which the pixels have a vertical aperture substantially equal to one third of the horizontal aperture thereof.

7. A display as claimed in any one of claims 3 to 6 when dependent on claim 2, in which the horizontal width of the slits is greater than or equal to the horizontal pixel aperture.

8. A display as claimed in any one of claims 3 to 6 when dependent on claim 2, in which the horizontal width of the slits is substantially equal to the horizontal pixel aperture.

9. A display as claimed in any one of claims 3 to 6 when dependent on claim 2, in which the parallax barrier is disablable to provide a single view mode of operation and the horizontal width of the slits is less than the horizontal pixel aperture.

10. A display as claimed in any one of the preceding claims, comprising a horizontally striped colour filter.

11. Use of pixels which are elongate substantially in a horizontal direction of a designed image orientation on the display to reduce crosstalk. in a multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing in respective different directions with respect to the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.

12. Use as claimed in claim 11, in which the images are for viewing by respective different viewers.

13. Use as claimed in claim 11 or 12, in which the parallax optic comprises a parallax barrier comprising a plurality of slits oriented in a vertical direction of the designed image orientation on the display.

14. Use as claimed in any one of claim 11 to 13, in which the pixels are rectangular with major axes extending substantially in the horizontal direction.

15. Use as claimed in any one of claims 11 to 14, in which the pixels are spaced apart horizontally with a constant horizontal pitch and have a horizontal aperture between 40% and 90% of the horizontal pitch.

16. Use as claimed in claim 15, in which the horizontal aperture is substantially equal to 70% of the horizontal pitch.

17. Use as claimed in any one of claims 11 to 16, in which the pixels have a vertical aperture substantially equal to one third of the horizontal aperture thereof.

18. Use as claimed in any one of claims 15 to 17 when dependent on claim 13, in which the horizontal width of the slits is greater than or equal to the horizontal pixel aperture.

19. Use as claimed in any one of claims 15 to 17 when dependent on claim 13, in which the horizontal width of the slits is substantially equal to the horizontal pixel aperture.

20. Use as claimed in any one of claims 15 to 17 when dependent on claim 13, in which the parallax barrier is disablable to provide a single view mode of operation and the horizontal width of the slits is less than the horizontal pixel aperture.

21. Use as claimed in any one of claims 11 to 20, in which the display comprises a horizontally striped colour filter.

22. A multiple view display comprising: a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing by respective different viewers in respective different directions with respect to the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions, the modulator further comprising a black mask defining pixel apertures of the pixels and having portions between pixel apertures, which are horizontally adjacent in the horizontal direction of the designed image orientation on the display, which portions are of at least two different widths.

23. A display as claimed in claim 22, in which the parallax optic comprises a plurality of parallax elements, each of which cooperates with a respective group of pixels.

24. A display as claimed in claim 23, in which the width of each portion of the black mask between pixels of the same group is greater than the width of each portion of the black mask between pixels of different groups.

25. A display as claimed in claim 23, in which the width of each portion of the black mask between pixels of the same group is less than the width of each portion of the black mask between pixels of different groups.

26. A display as claimed in any one of claims 22 to 25, in which the width of each portion of the black mask between pixels of the same group is between substantially 32% and substantially 48% of the horizontal pixel pitch.

27. A display as claimed in any one of claims 22 to 25 or in claim 26 when dependent on claim 24, in which the width of each portion of the black mask between pixels of different groups is between substantially 16% and substantially 24% of the horizontal pixel pitch.

28. A display as claimed in any one of claims 22 to 27, in which the parallax optic comprises a parallax barrier comprising a plurality of slits oriented in a vertical direction of the designed image orientation on the display.

29. A display as claimed in claim 28, in which the horizontal width of the slits is substantially equal to the horizontal pixel aperture.

30. A multiple view display comprising a spatial light modulator comprising a plurality of pixels arranged to display a plurality of spatially interlaced images for viewing by respective different viewers in respective different directions with respect to the display, each pixel having no portion with a minimum width, in the horizontal direction of the designed image orientation on the display, less than substantially half

the horizontal pixel aperture; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator by the different images to the respective different directions.

31. A display as claimed in claim 30, in which the parallax optic comprises a parallax barrier.

32. A display as claimed in claim 30 or 31, in which each pixel has a substantially rectangular aperture.

33. A display as claimed in claim 30 or 31, in which each pixel has an aperture comprising a plurality of substantially rectangular sub-apertures.

34. A multiple view display comprising: a spatial light modulator comprising a plurality of rows of pixels arranged as sets, each row extending in the horizontal direction of the designed image orientation on the display, the sets of rows being arranged to display interlaced horizontal strips of a plurality of images for viewing by respective different viewers in respective different directions with respect to the display; and a parallax optic cooperating with the modulator substantially to restrict light from the modulator modulated by the different images to the respective different directions.

35. A display as claimed in claim 34, in which each set comprises one row.

36. A display as claimed in claim 34 or 35, in which the parallax optic comprises a plurality of horizontal rows of microlouvres oriented in the different directions, each row cooperating with a respective set.

37. A display as claimed in any one of claims 34 to 36, comprising a horizontally striped colour filter.

38. A display as claimed in any one of the preceding claims, comprising a controller for supplying to the modulator pixel data in a form suitable for interlacing the images.

39. A display as claimed in any one of the preceding claims, in which the modulator comprises a light valve.

40. A display as claimed in claim 39, in which the modulator comprises a liquid crystal device.

41. A display as claimed in any one of the preceding claims, in which the plurality of images comprises two images.

42. A display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor arranged to add to a pixel value of each pixel of each image to be displayed a predetermined grey level to form a sum and to subtract from each sum an optical crosstalk correction value which is a function of: the value of at least one other pixel of another of the images to be displayed; and a mapping relating pixel intensity to grey level for the display.

43. A controller as claimed in claim 42, in which the predetermined grey level is the same for all pixels.

44. A controller as claimed in claim 43, in which the predetermined grey level represents a maximum possible crosstalk contribution.

45. A controller as claimed in any one of claims 42 to 44, in which the at least one other pixel comprise one other pixel.

46. A controller as claimed in claim 45, in which the other pixel is of a same colour.

47. A controller as claimed in any one of claims 42 to 46, in which the crosstalk correction value is also a function of the pixel value to be corrected.

48. A display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor arranged to add to each pixel value of at

least some pixels of the display an electrical crosstalk correction value which is a function of electrical crosstalk within the display.

49. A controller as claimed in claim 48, in which the function comprises a function of the pixel value to be corrected and the value of at least one other pixel.

50. A controller as claimed in claim 49, in which the at least one other pixel comprises an adjacent pixel.

51. A controller as claimed in claim 49 or 50, in which the function further comprises a function of a mapping relating pixel intensity to grey level for the display.

52. A display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor arranged to add to at least one of the images a masking image for masking crosstalk between images.

53. A controller as claimed in claim 52, in which the processor is arranged to add the same masking image to each of the images.

54. A controller as claimed in claim 52 or 53, in which the masking image comprises noise.

55. A controller as claimed in claim 52 or 53, in which the masking image comprises random text.

56. A controller as claimed in any one of claims 52 to 55, in which the masking image is a static image.

57. A controller as claimed in any one of claims 52 to 55, in which the masking image is a changing image.

58. A controller as claimed in claim 52 or 53, in which the masking image is a grey level.

59. A controller as claimed in claim 58, in which the processor is arranged to add the grey level when the at least one image is substantially black.

60. A controller as claimed in any one of claims 52 to 29, in which the masking image has a maximum brightness substantially equal to 5% of the maximum display brightness.

61. A controller as claimed in any one of claims 52 to 60, in which the masking image has a maximum brightness equal to or greater than ten times the maximum expected crosstalk brightness.

62. A display controller for supplying data for displaying a plurality of images to a multiple view display, comprising a processor for reducing image brightness in response to a signal indicative of reduced ambient light.

63. A controller as claimed in claim 62, comprising a light sensor for providing the signal.

64. A controller as claimed in claim 62 for a display installed in a vehicle, comprising an input for receiving the signal which is indicative of illumination of vehicle headlamps.

65. A controller as claimed in any one of claims 42 to 64, in which the plurality of images comprises two images.

66. A controller as claimed in any one of claims 42 to 65, in combination with a display as claimed in any one of claims 1 to 41.

Application No: GB0501469.1 Examiner: Mr Jeremy Cowen
Claims searched: 1,11 Date of search: 20 April 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 & 11 at least	GB2396070 A (Sharp KK), see esp figure 6 and page 8, lines 13-22
X	1 & 11 at least	GB2403367 A (Sharp KK), see esp figure 9 and last 2 paragraphs of page 13
X	1 & 11 at least	GB2317734 A (Sharp KK), see esp figures 10 & 17-20
X	1 & 11 at least	GB2278223 A (Sharp KK), see esp figures 1,3,9,10 & claim 8
X	1 & 11 at least	GB2315902 A (Sharp KK), see figure 9b & page 10, line 23 - page 11, line 7
X	1 & 11 at least	GB2311905 A (Samsung Electronics Co Ltd), see esp figure 7
X	1 & 11 at least	GB2403863 A (Ocuity Limited), see esp figures 11-13 & 15-17

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

H4F

Worldwide search of patent documents classified in the following areas of the IPC^{07}

G02B; H04N

The following online and other databases have been used in the preparation of this search report

WPI,EPODOC

INVESTOR IN PEOPLE

34

Application No: GB0501469.1 **Examiner:** Mr Jeremy Cowen

Claims searched: 22 **Date of search:** 15 August 2005

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	22-25 at least	GB2278223 A (Sharp KK), see esp figure 12
X	22,23 at least	US4829365 A (Dimcnsion Techonologies), sec column 8, lines 38-44, column 9, lines 10-18 and figure 14

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

G2F; H4F

Worldwide search of patent documents classified in the following areas of the IPC^{07}

G02B; G02F; H04N

The following online and other databases have been used in the preparation of this search report

WPI,EPODOC,PAJ

The Patent Office

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Application No: GB0501469 1   35   **Examiner:** Mr Jeremy Cowen

Claims searched: 30   **Date of search:** 16 August 2005

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	30-32	GB2403637 A (Sharp KK), see figures
X	30-32	GB2403864 A (Sharp KK), see esp figures 5,6
X	30-32	GB2396070 A (Sharp KK), see esp figures 6-9
X	30-32	GB2320156 A (Sharp KK), see figure 3
X	30-33	GB2309609 A (Sharp KK), see composite pixels 20,21, figure 3 and pages 2-3

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

G2F; H4F

Worldwide search of patent documents classified in the following areas of the IPC^{07}

G02B; G02F; H04N

The following online and other databases have been used in the preparation of this search report

WPI,EPODOC,PAJ

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Application No:	GB0501469.1	**Examiner:**	Mr Jeremy Cowen
Claims searched:	34	**Date of search:**	16 August 2005

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	34-41	GB2403863 A (Ocuity Ltd) , see esp figures 12b,17a,17b
X	34-41	GB2403864 A (Ocuity Ltd), see esp figs 13,18
X	34-41	US2004/252374 A1 (Hirayama & Saishu), see whole document
X	34-41	GB2396070 A (Sharp KK), see whole document
X	34-41	GB2305048 A (Thomson Multimedia), see whole document
X	34-41	US4829365 A (Dimension Technologies), see whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

G2F; H4F

Worldwide search of patent documents classified in the following areas of the IPC^{07}

G02B; G02F; H04N

The following online and other databases have been used in the preparation of this search report

WPI,EPODOC,PAJ

Application No: GB0501469.1 37 Examiner: Mr Jeremy Cowen

Claims searched: 42,48,52 Date of search: 19 August 2005

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	42-44,48,52, 58 at least	GB2336963 A (Sharp KK), see page 12 (last para) to page 17, figures 13,14 and claim 11
A	-	JP08331600 A (Sanyo Electric Co), see abstract
A	-	JP2004206050 A (Victor Co of Japan), see abstract

Categories:

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Field of Search:

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The following online and other databases have been used in the preparation of this search report

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The Patent Office

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Application No: GB0501469.1 38

Claims searched: 62

Examiner: Mr Jeremy Cowen

Date of search: 22 August 2005

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X:62,63,65 Y: 64	GB2389730 A (Mitac International Corp), see whole document
X,Y	X: 62,63,65 Y:64	GB2341033 A (LG Electronics), see whole document
X,Y	X: 62,63,65 Y:64	US5270818 A (AlliedSignal Inc), see whole document
X,Y	X: 62,63,65 Y:64	US6337675 B1 (UT Automotive Dearborn), see whole document, note application in controlling vehicle displays
X,Y	X: 62,63,65 Y:64	JP02185175 A (Nippon Electric Co), see abstract & figures
X,Y	X: 62,63,65 Y:64	JP60224383 A (Daihatsu Motor Co Ltd), see abstract
Y	Y: 64	JP63105583 A (Sony Corp), see abstract & figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

H4F

39

Worldwide search of patent documents classified in the following areas of the IPC[07]

H04N

The following online and other databases have been used in the preparation of this search report

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