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Display Systems

This invention concerns display systems and more particularly systems for displaying a plurality of images produced using a display grid having a plurality of strips of the respective images arranged in substantially parallel relation to each other so that an appropriate masking grid can reveal individual images through substantially parallel window slits in the masking grid, different images being produced by relative movement between the image and masking grids.

Typically such display systems consist of a casing in which one of the grids is held in a static position whilst the other is moveable relative to the static grid using a drive mechanism, a light behind the grids illuminating the various images when relative motion between the grids is stopped for periods during which the various images are displayed.

In order for such systems to work correctly, not only do the grids have to be kept in close contact whilst the various images are being shown in order to avoid patterning caused by the

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adjacent strips of images on the image grid being seen simultaneously through the masking grid resulting from air trapped between the grids, but the window strips of the masking grids need to be kept in alignment with the image strips of the image grid to prevent parts of different strips being seen through the masking grid at any one time, and the relative motion also needs to be controlled so that when the motion is stopped, strips of only one image are revealed by the window strips of the masking grid.

The problem of keeping the grids in contact with each other has been addressed in WO 98/41967, compression of the outer edges of the grids being used to urge them into a curve and at the same time force one grid into intimate contact with the other.

WO 98/41967 also addresses the problem of maintaining the strips of the respective grids in parallel relationship using a stepper motor to move each of the edges of the moveable grid. Once the motors have been independently adjusted to bring the image strips and the masking grid window strips into parallel alignment, operating the motors to move the moveable grid in steps of a predetermined amount can then be used to show the respective images in turn, and the process can be run continuously by reversing the direction of the motors at the desired limits of travel of one grid relative to the other.

Although alignment of and registration between the image strips of the image grid and the window strips of the masking grid can be maintained by this method if the two grids and the stepper motors are absolutely perfect. However, in practice slight inaccuracies in printing of the image strips can result in strips of slightly different widths. This problem can be reduced to some extent by making the window strips in the masking grid substantially narrower than the individual image strips, for example by using image strips 0.45mm wide with window strips in the masking grid 0.225mm wide. However, in extreme cases parts of two image strips can be displayed during

a particular dwell period, this problem potentially being cumulative.

The performance of individual stepper motors and the mechanical linkages used to drive the moveable grids can also lead to misalignment of the grids during the working cycles of display systems which use them, particularly bearing in mind the small displacements between adjacent dwell positions of the grids.

These alignment and registration problems are addressed in WO 98/41967, it being proposed to provide the image grid with window strip extensions at each end of a succession of image strips, the window strips of the masking grid being sufficiently long that light from a LED behind the grids can be detected by a photocell placed in front of the grids when the image strips of the image grid are aligned with the window strips of the masking grid. Using window strip extensions of the image strips which are the width of the window strip of the masking grid, opaque regions can be provided between adjacent window strip extensions of the image strips. Furthermore, having the window strips in the two grids of the same width facilitates the determination of registration between the grids, alignment being achieved when the output from the photocells is a maximum.

Although the above method enables alignment and registration to be achieved between the two grids using the outputs from two photocells positioned over opposite edge portions of the grids to control stepper motors which drive the two edged of the moveable grid, the determination of the exact position of the maximum output is difficult in practice. More particularly, since the occurrence of the maximum is only apparent after it has been observed, i.e. once the output of the photocells starts to fall, the position at which the stepper motors stop relative movement between the grids will differ depending on whether the drive is moving the moveable grid up or down.

Positioning of the window strips along the center line of the image strips is therefore impossible using this method.

However, this is taken into account by making the window strips of the masking grid narrower than the image strips of the image grid, but whilst alignment and registration can be achieved using this method it is at the expense of the amount of light which can pass through the display.

According to the present invention there is provided an image display system for displaying a plurality of images using an image grid comprising a plurality of strips of the respective images arranged in sequence and in substantially parallel relationship to each other, and a masking grid comprising a plurality of substantially parallel window strips for selectively obscuring image strips of the image grid to enable different images to be viewed when the grids are moved relative to each other, opposing edge portions of the respective grids each including indicia for use in aligning the strips of the respective grids, said indicia at each edge portion comprising a substantially transparent window slit in an opaque region of one grid and a region of the other grid including a transition from transparent to opaque, said window slit and said transition from transparent to opaque being substantially parallel to the image strips and to the window strips when the grids are correctly aligned, the system comprising:-

(a) drive means for moving opposite edges of one grid relative to the other to display the said images;

((b) control means for controlling the drive means to adjust the position of the image grid relative to the masking grid; and

(c) sensor means comprising:-

(i) light sources positioned to direct light at the indicia at the said edge portions of the two grids;

(ii) light detector means for detecting light from the respective light sources which passes through the respective indicia of the two grids;

- (iii) amplifier means for amplifying the outputs of the light detector means; and
- (iv) comparator means for providing an output signal to the control means to actuate the drive means in response to the difference between the outputs from the amplifier means and a predetermined reference level;

the gains of the respective amplifier means being adjustable so that the transitions from transparent to opaque for the indicia at opposite edge portions of the grids can both be positioned substantially half way across the corresponding window strips of the other grid at substantially the same time thereby bringing the image strips of the image grid into substantially parallel alignment with the window strips of the masking grid, and further so that relative movement between the grids can be stopped by the control means when the grids are in the same position thereby enabling different images on the image grid to be displayed.

Display systems in accordance with the present invention can achieve particularly good alignment and registration between elements of image and masking grids placed in them, and this can be effected automatically. Furthermore, this good alignment and registration enables the window strips of the masking grids to be widened relative to the widths of the image strips of the image grids, thereby enabling brighter images to be obtained.

An embodiment of image display system in accordance with the present invention will now be described with reference to the accompanying diagrammatic drawings in which:-

Fig. 1 shows a block diagram of the embodiment;

Figs 2A-D illustrate the effects of relative movement between a masking grid and an image grid positioned in the system; and

Fig. 3 is a graph representing the output of from a photocell used to detect light transmission through the grids as they are moved relative to each other.

In Fig. 1, an image grid 1 which is viewed edge on is secured in a display system similar to that described with reference to Fig. 12 of WO 98/41967, a masking grid 2 being in intimate contact with the image grid 1 by compression of the grids from their edges, again as described in WO 98/41967. The masking grid 2 is slideable relative to the image grid 1 using a pair of stepper motors 3 which are each connected to one side of the image grid 1 by a linkage 4, only one stepper motor and linkage being shown in Fig. 1.

Two LEDs 5 and 5' are positioned facing an edge portion of one side of the pair of grids 1 and 2, and two photocells 6 and 6' are positioned facing the other side of the pair of grids 1 and 2. Two similar pairs of LEDs and photocells which are not shown are positioned facing edge portions of the other side of the grids 1 and 2, and they perform a similar function to that of the LEDs 5 and 5' and to the associated photocells 6 and 6'. The photocells 6 and 6' are each connected to an amplifier 7, 7', the amplifiers 7 and 7' having their own manual gain controls 8 and 8', respectively.

The respective outputs from the amplifiers 7 and 7' are fed to comparators 9 and 9', preset voltage levels being supplied to the comparators 9 and 9' from reference voltage supplies 10 and 10'. The voltage supplies 10 and 10' are shown as being separate, but preferably a single reference voltage is used for both comparators 9 and 9', and indeed for all four comparators including the two which are not shown.

The outputs from the comparators 9 and 9' are fed via lines 11 and 11' respectively to a control unit 12 which controls the motor 3. The outputs from the two comparators which are not

shown are fed to a separate control unit which controls the other stepper motor, the latter not being shown.

The use of two photocells 6 and 6' enables two different control functions to be carried out by the control unit 12, the first, which is carried out using photocell 6 and its equivalent facing the other edge portion of the grid 2, is to align the grids with the image strips of the image grid 1 parallel to the window strips of the masking grid 2, the second which uses the output of the photocell 6' is to maintain registration between these strips during cycling of the display of images using the system.

Reference will now be made to Figs. 2A-D and Fig. 3 which show how the outputs from the respective photocells change with movement of the masking and image grids relative to each other. Only portions of the two grids are shown, and they have been slid apart sideways to make it clearer as to what happens when the grids are moved up and down relative to each other.

In Figs. 2A-D, the image grid 1 has a window slit 20 with the photocell 6 behind, the field sensed by the photocell 6 being shown in each case by a broken line 21. The masking grid 2 has an opaque region 22 and a transparent portion 23 with a boundary line 24 therebetween.

With the image grid 1 positioned behind the masking grid 2 in the position represented by Fig. 2A, that is with the boundary 24 coincident with the upper edge of the field 21, light from the LED 5 is blocked by opaque regions of both the image grid 1 and the masking grid 2. However, the opaque regions of the grids are not perfectly opaque, and they allow a low level of light to reach the photocell 6, resulting in a residual output as shown at A in Fig. 3.

Downward movement of the masking grid 2 relative to the image grid 1 to the position shown in Fig. 2B results in a gradual increase in the output from the photocell 6 as progressively more but still a low level of light reaches it through the

opaque regions of the masking grid on either side of the window strip 20. The output from the photocell 6 is then as shown at B in Fig. 3.

Movement of the masking grid 2 from the position represented by Fig. 2B to that represented by Fig. 2C results in a very rapid and large increase in output from the photocell 6, the output represented by Fig. 2C being shown at C in Fig. 3.

Further downward movement of the masking grid 2 relative to the image grid 1 to the position shown in Fig. 2D results in a small increase in output to that shown at D in Fig. 3, after which further downward movement of the masking grid 2 has no effect on the output of the photocell 6.

Reversing the series of steps through the positions shown in Figs. 2D-A results in the output from the photocell 6 changing in the reverse sense to reach the output shown at A in Fig. 3.

The illustrated display system uses travel of the boundary 24 across the window strip 20 to establish alignment between the image strips of the image grid 1 and the window strips of the masking grid 2, but rather than do so when the window strip 20 of the masking grid 2 is either completely covered by or completely uncovered by the opaque region 22 of the image grid 1, alignment is effected when the boundary 24 is positioned substantially half way across the strip 20. A suitable positioning of the boundary 24 (and its counterpart in the opposite edge portion of the image grid 1) relative to the image strips can enable this to occur. This is represented by the point M in Fig. 3.

Although it might be thought that the point M represents half the maximum output of the photocell 6, the latter is at a different position M' due to the residual light transmission even through two overlapping opaque regions of the grids 1 and 2. The result is that even if M' were to be computed from the

maximum output of the photocell 6, the desired alignment between the grids would still not be achieved.

The present invention overcomes this problem by comparing the amplified output of the photocell 6 with a reference voltage supply 10 which will in general be an arbitrary approximation to 50% of the maximum output of the photocell 6. Since this level is arbitrary, the same reference source can be used as the voltage supply 10, 10' and reference voltages for the two comparators which are not shown. If there is an inequality between the reference voltage and the amplified output, the comparator 9 feeds a signal to the control unit 12 which in turn sends a signal to the stepper motor 3 move the masking grid 2 so that the difference between these voltages is brought to zero.

Adjustment of the gain of the amplifier 7 using the manual gain control 8 has the effect of scaling the graph shown in Fig. 3 so that the point M on the graph is brought to the reference voltage 10, indicated at P in Fig. 3. This scaling effect is indicated by the double headed arrow I-I in Fig. 3, and it has the effect of moving all points on the photocell output axis by the gain factor of the amplifier. The gain of the amplifier, which may be positive or negative, can therefore be adjusted to bring the boundary 24 exactly into line with the center line of the window strip 20, this conveniently being effected by eye, but is could be effected using a suitable instrument which indicates relative displacement between the two grids.

If the stepper motor 3 stops with the boundary 24 in a different position relative to the window strip 20 when the masking grid 2 is being moved up rather than down, it will usually be possible to bring both stopping positions nearer to the desired central position by adjustment of the amplifier gain.

The configuration of image and masking grids shown with reference to Figs. 2A-D and 3 is particularly suitable for automatically bringing window strips of the masking grid into alignment with image strips of the image grid, the LED and

photocell which are not shown but are disposed adjacent the opposite edge portion of the pair of grids serving to achieve a similar effect.

The LED 5' and its associated photocell 6' function in a similar manner to LED 5 and photocell 6, but are used to achieve and maintain registration between the image strips of various image strips with the window strips of the masking grid. However, instead of a single light to dark boundary, a succession of light to dark and dark to light boundaries can be used to effect this, the boundaries being aligned with the center lines of the image strips of the image grid so that dwell periods are obtained with the window strips of the masking grid 2 being as far as possible aligned centrally with the image strips of the image grid 1.

The LEDs 5 and 5', and the associated photocells 6 and 6', can be positioned at various positions within the display systems, subject, of course, to the grids used in the systems having the appropriate indicia to effect alignment and/or registration of the window strips in the masking grid with the image strips of the image grid.

As will be appreciated, display systems in accordance with the present invention can be arranged to move the image grid rather than the masking grid.

It will also be appreciated that either the alignment system or the registration system can be omitted, neither being preferred. If the alignment system is omitted, it might be possible to use the registration system to effect alignment, but even if this were possible at start up with the grids incorrectly aligned, alignment during operation of the system, for example required as a result of physical vibration of the system, will be difficult if not impossible to achieve.

Reliance of the alignment system to bring the window and image strips into correct registration should be possible, but the use

of the registration system does enable mis-registration resulting from imperfections in printing of the image strips to be overcome.

In addition to being able to compensate for the effects of residual light transmission through the grids, this being particularly noticeable when some inks are used to print opaque areas of the grids, the present invention enables the effects caused by the wide range of light outputs from individual LEDs, the wide range of responses to light exhibited by different photocells, and the changes in properties of individual LEDs and photocells during use, to be compensated for merely by adjusting the gain of the respective amplifiers to bring a light to dark boundary on one grid into the desired position relative to a window slit in the other grid.

Claims

1. An image display system for displaying a plurality of images using an image grid comprising a plurality of strips of the respective images arranged in sequence and in substantially parallel relationship to each other, and a masking grid comprising a plurality of substantially parallel window strips for selectively obscuring image strips of the image grid to enable different images to be viewed when the grids are moved relative to each other, opposing edge portions of the respective grids each including indicia for use in aligning the strips of the respective grids, said indicia at each edge portion comprising a substantially transparent window slit in an opaque region of one grid and a region of the other grid including a transition from transparent to opaque, said window slit and said transition from transparent to opaque being substantially parallel to the image strips and to the window strips when the grids are correctly aligned, the system comprising:-

- (a) drive means for moving opposite edges of one grid relative to the other to display the said images;
- (b) control means for controlling the drive means to adjust the position of the image grid relative to the masking grid; and
- (c) sensor means comprising:-
 - (i) light sources positioned to direct light at the indicia at the said edge portions of the two grids;
 - (ii) light detector means for detecting light from the respective light sources which passes through the respective indicia of the two grids;
 - (iii) amplifier means for amplifying the outputs of the light detector means; and

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- (iv) comparator means for providing an output signal to the control means to actuate the drive means in response to the difference between the outputs from the amplifier means and a predetermined reference level;

the gains of the respective amplifier means being adjustable so that the transitions from transparent to opaque for the indicia at opposite edge portions of the grids can both be positioned substantially half way across the corresponding window strips of the other grid at substantially the same time thereby bringing the image strips of the image grid into substantially parallel alignment with the window strips of the masking grid, and further so that relative movement between the grids can be stopped by the control means when the grids are in the same position thereby enabling different images on the image grid to be displayed.

2. A display system according to claim 1, including separate sensor means for aligning the image strips of the image grid with window strips of the masking grid and for maintaining registration between image strips of the image grid and window strips of the masking grid.

3. A display system according to either of the preceding claims, wherein the masking grid is moved by the drive means and the image grid is static.

4. A display system according to any of the preceding claims, wherein the same predetermined reference level is used by both or all of the comparators.

5. A display system according to any of the preceding claims, wherein the predetermined reference level is approximately half the unamplified output of the respective light detector means.

6. A display system substantially as herein described with reference to the accompanying drawings.

7. A method of displaying a plurality of images which comprises using a display system according to any of the preceding claims.
8. A method according to claim 7, wherein the respective gains of the amplifier means are adjusted manually in response to a visual assessment of the relative displacement between the two grids.
9. A method according to claim 7 or claim 8, wherein opaque regions of the indicia are imperfectly opaque and allow light from the light sources to pass therethrough to light detector means.
10. A method of displaying a plurality of images, the method being substantially as herein described.