

**DISPLAY SYSTEM WITH SECONDARY
VIEWING IMAGE CAPABILITIES**

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FIELD OF THE INVENTION

The present invention relates to displays, and more particularly, to appearances of displays from various angles.

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CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of prior pending U.S. Provisional Patent Application No. 60/185,151, filed February 17, 2000.

BACKGROUND OF THE INVENTION

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With the rapid proliferation of electronic technology into nearly every aspect of modern life, the importance of the interface between machine and human has intensified dramatically. Applications frequently demand power conservation and compactness, causing many designers to adopt liquid crystal displays (LCDs) as the preferred interface for providing information to the user. LCDs are commonly used in cellular telephones and portable computers, and are increasingly used in higher information content systems, such as flat panel televisions and projection systems.

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Although a wide variety of LCDs have been developed, with reference to Figure 1, a typical LCD 100 comprises a pair of substantially transparent substrates 102 and 104 having spacers 110 disposed between them. A liquid crystal medium 112 fills the gap formed between the substrates 102, 104 and maintained by the spacers 110. The substrates include an array of electrodes, typically in a grid pattern of pixels, to apply an electric field across selected portions of the liquid crystal medium 112. An electric field causes the liquid crystal medium 112 to change the polarization of light transmitted through the crystal. The light transmitted through the liquid crystal medium 112 passes



through a polarizer 116 that only transmits light polarized in a selected direction. Thus, by applying appropriate electric signals to the electrodes, images may be formed on the display 100 in a primary viewing angle 114.

In addition to the substrates 102 and 104 and the polarizer 106, the LCD 100 may also comprise a light source adapter 108 that is suitably configured to increase the viewing capabilities of the desired image in the primary viewing angle 114. Typically, the light source adapters 108 may comprise polarizing materials, reflective materials, such as aluminum, aluminate plastic, a reflective lamination on a glass substrate, and the like, or may comprise transmissive materials, such as substantially clear plastics or other polymers and the like. As such, light from a light source may be directed by the light source adapter 108 by reflection from a reflective surface or by transmission through the adapter 108 through the pair of substrates 102 and 104 and the liquid crystal medium 112. Further, these various light source adapters 108 are typically laminated onto the backside of the LCD 100. These various light sources adapters have been developed to optimize the contrast, as well as brightness, of an image in the primary viewing angle 114.

Unfortunately, while being effective in providing readily visible imaging in a primary viewing angle, present display systems do not provide secondary viewing image capabilities that could afford various marketing and other information providing advantages to developers and manufacturers of display systems, such as LCDs.

SUMMARY OF THE INVENTION

A display system according to various aspects of the present invention includes a system and method for providing a primary and secondary viewing image within the display system. Such a display system includes an imaging system and an illumination system. Although an exemplary embodiment of the imaging system comprises an LCD system, the imaging system may also comprise any system configured for providing images to a viewer. The illumination system suitably directs light through the imaging system to

facilitate a primary viewing image and a secondary viewing image. In accordance with one exemplary embodiment, the primary viewing image comprises a variable image while the secondary viewing image comprises a fixed image. Moreover, in an exemplary embodiment, the secondary viewing image can provide the fixed image
5 regardless of the activity of any LCD material within the imaging system.

A first possible expression of the invention is a display system for providing images to a viewer, said display system comprising:

an electronic imaging system, and
an illumination system, wherein said illumination system directs light through
10 said imaging system to provide simultaneously a primary image in a primary viewing angle and a secondary image in a secondary viewing angle, wherein the primary image is generated by the electronic imaging system and the secondary image is a constant image independent from the electronic imaging system.

A second possible expression of the invention is a display system for
15 transmitting viewing images, said system comprising:

a first substrate;
an LCD material;
a second substrate disposed adjacent and parallel said first substrate, said LCD material being contained between said first substrate and said second substrate; and
20 an illumination system for directing light through said first substrate and said second substrate to produce simultaneously a primary image within a primary viewing angle and a secondary image within a secondary viewing angle, said primary viewing image being a variable image and said secondary image being a constant image independent from the LCD.

25 A third possible expression of the invention is a method for displaying images to a viewer, said method comprising the steps of:

providing an electronic imaging system for providing a primary image;
directing a light source from an illumination system through said imaging system to provide said primary image in a primary viewing angle, said primary image being a
30 variable image, and

a secondary image in a secondary viewing angle, said secondary image being a constant image independent from the electronic imaging system.

A fourth possible expression of the invention is a display system for displaying images to a viewer comprising:

5 a first polarizer;

a first transparent substrate disposed adjacent and parallel said first polarizer;
an LCD material;

a second transparent substrate being disposed adjacent and parallel said first transparent substrate, said LCD material being contained between said first transparent
10 substrate and said second transparent substrate;

a second polarizer disposed adjacent and parallel said second transparent substrate;

and an illumination device for directing light through said second polarizer, said second substrate, said LCD material, said first substrate and said first polarizer to
15 provide simultaneously a primary viewing image in a primary viewing angle and a secondary viewing image in a secondary viewing angle, said primary viewing image being a variable image as controlled by the activity of the LCD material and said secondary viewing image being a fixed image regardless of the activity of the LCD material.

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BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention may be derived by referring to the detailed description and claims when considered in connection with the figures, where like reference numbers refer to similar elements throughout the figures,
25 and:

Figure 1 is a cross section diagram of a prior art display system;

Figure 2 is a diagram of an exemplary display system in accordance with various aspects of the present invention;

Figure 3 is a diagram of an alternative embodiment of a display system in
30 accordance with various aspects of the present invention

Figure 4 is a cross-section of a prism sheet having multiple sets of substantially parallel surfaces; and

Figure 5 is a three-dimensional representation of a primary viewing image and a secondary viewing image in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE
INVENTION

The present invention is described in part in terms of functional components and various processing steps. Such components and steps may be realized by any number of materials configured to perform the specified functions. In addition, the display systems

described may incorporate various additional components configured for providing imaging capabilities. For example, the present invention may employ various integrated circuit components, drivers, signal processors and the like, which may carry out a variety of functions under the control of one or more microprocessors or other control devices.

5 The present invention may be practiced in any number of contexts and the display system described herein is merely one exemplary application for the invention.

In accordance with various aspects of the present invention, a display system and method provides multiple images at multiple viewing angles, thus affording various marketing and other advantages to developers and manufacturers of display systems, such as LCDs. Accordingly, the display system can be incorporated into various information
10 content devices, such as cellular telephones, automatic teller machines, and portable computers, as well as televisions and projection systems, to provide a more flexible and useful system for displaying information and images.

In accordance with an exemplary embodiment, with reference to Figure 2, a display system 200 includes an imaging system 202 and an illumination system 204. The
15 imaging system 202 suitably comprises any system configured for providing images to a viewer. The illumination system 204 suitably comprises a device configured for directing light through the imaging system 202 to provide a primary image within a primary viewing angle 206 and a secondary viewing image within a secondary viewing angle 208.

20 The imaging system 202 suitably comprises any appropriate system configured for providing images to a viewer in conjunction with the illumination system 204. The imaging system 202 is suitably configured to transmit and/or reflect light from the illumination system 204 to provide a primary image within a primary viewing angle 206 and a secondary viewing image within a secondary viewing angle 208. In the illustrative
25 exemplary embodiment, the imaging system 202 comprises a conventional LCD panel 100 as shown in Figures 1 and 3.

Referring to Figure 3, for an imaging system 302, the first substrate 304 and second substrate 306 suitably comprise any substantially transparent material configured to maintain the liquid crystal medium 312 between them. Preferably, the first substrate 304 and second substrate 306 are configured with the second substrate 306 disposed adjacent and parallel to the first substrate 304 to contain the liquid crystal medium 312 in a gap formed between the substrates 304, 306. Further, to maintain separation between the substrates 304 and 306, spacers 310 may be included within the liquid crystal medium 312. Still further, to facilitate containment of the liquid crystal medium 312 between the substrates 304 and 306, a sealer 308 is provided to seal off and prevent leakage of the medium 312. The first substrate 304, and in the present embodiment the second substrate 306, transmit light to provide images. The first and second substrates 304, 306 can comprise conventional glass utilized in LCD systems, or any other appropriate material, such as plastic films and the like. Each of the substrates 304, 306 is also suitably equipped with an array of substantially transparent electrodes (not shown) formed on the substrates, such as electrodes configured in a grid pattern of pixels, to selectively apply an electric field across portions of the liquid crystal medium 312.

The liquid crystal medium 312 suitably comprises any known medium capable of reacting to electric fields, such as the electric fields provided by electrodes within substrates 304 and 306, to change the polarization of light transmitted through the crystal medium 312 and thus through the substrates 304 and 306. For example, the liquid crystal medium 312 may suitably comprise nematic, cholesteric, or smectic-type liquid crystals.

The imaging system 302 also suitably includes at least one polarizer 314 configured to transmit only light polarized in a selected direction. In the present embodiment, the first and second polarizers 314 and 316 are suitably configured to transmit light polarized in a selected direction. In accordance with the preferred exemplary embodiment, the first and second polarizers 314 and 316 are configured to polarize the light to permit the providing of primary and secondary viewing images.

Accordingly, the first and second polarizers 314 and 316 may each suitably comprise an optical filter. Moreover, the first and second polarizers 314 and 316 may include another optically active filter, such as a retarder, to provide yet a higher contrast for a display image.

5 Though the imaging system 302 described above comprises a conventional LCD panel, the present invention is not so limited, and may be adapted to several display systems, such as CRT or projection systems and the like. The imaging system 202 may generally comprise any imaging system that allows light to be directed by an illumination system 204 to provide a primary image at a primary viewing angle and one or more
10 supplementary images at one or more alternative viewing angles. Accordingly, the imaging system may comprise any system that operates as a light valve, or a light filter, such as a spacial light modulator and the like, which can modulate light in different spaces.

 The illuminating system 204 is configured for directing light through the imaging system 202 to provide multiple images corresponding to multiple potential viewing angles.
15 For example, the illuminating system 204 may be configured to provide a primary image in a primary viewing angle 206 and a secondary viewing image in a secondary viewing angle 208. In the present embodiment, the primary image provided to a viewer within the primary viewing angle comprises the image generated by the imaging system. For a computer system, the primary image may be the text or graphics, e.g., pictorial logos and
20 the like, provided in a conventional display. Likewise, for an automatic teller machine (ATM), the primary image comprises the text and graphics for communicating with the customer. Thus, the primary image may comprise the information intended for the operator or user of the display system. In addition, the primary image is not limited to text or graphics, but may also comprise a uniform image of brightness, for example, a silver
25 and/or black or other color background, and is not limited to any one type of image configuraton.

The secondary image is provided to a viewer that is outside the primary viewing angle, such as next to the computer user or behind the ATM customer. The secondary image suitably comprises a constant image unrelated to the primary image. For example, the secondary image may comprise the name and logo of the computer manufacturer or the bank associated with the ATM. Additional images may be added for additional viewing angles, such that multiple sponsors or the like may feature information to viewers outside the primary viewing angle. In the present embodiment, the secondary image provided by the illuminating system 204 is configured for viewing at an angle so as not to impede or diminish the viewing of the primary viewing image.

The boundary between the primary viewing angle and the secondary viewing angle may be selected according to any suitable criteria. For example, the primary viewing angle of the illumination system 204 suitably substantially coincides with an optimal viewing angle of the imaging system 202. An LCD typically exhibits an optimal viewing angle exhibiting optimal contrast and brightness. Outside the optimal viewing angle, the contrast and brightness diminish significantly. By selecting the primary viewing angle of the illumination system 204 to correspond to the optimal viewing angle of the imaging system 202, the user within the primary viewing angle observes a bright, high-contrast image of the information provided by the imaging system 202, while observers outside the primary viewing angle and the optimal viewing angle of the imaging system see a relatively dim secondary image. Alternatively, the primary viewing angle of the illumination system may be narrower than the optimal viewing angle for the imaging system. A narrow primary viewing angle tends to provide privacy from observers outside the primary viewing angle, such as passersby at an ATM.

The illuminating system 204 may comprise any suitable system for providing different images to viewers at different viewing angles. In accordance with an exemplary embodiment, the illuminating system 204 comprises a hologram to provide a first image to a viewer within the primary viewing angle and one or more other images to viewers

outside the primary viewing angle. Within the primary viewing angle, the hologram is suitably configured as a holographic optical element configured to receive light over a broad angle and transmit or reflect light over a relatively narrow angle. As a result, the hologram tends to enhance the brightness of light provided to viewers within the primary viewing angle and diminish the brightness of light to viewers outside the primary angle.

For example, with momentary reference to Figure 5, an exemplary embodiment of a display system having a primary viewing image 502 and a secondary viewing image 504 is illustrated. In accordance with this embodiment, the primary viewing image 502 may be viewed from a plurality of optimal viewing angles, as defined by viewing cone 506. In addition, the secondary viewing image 504 may be viewed from a plurality of secondary viewing angles, defined by secondary viewing cone 508. The volumetric viewing areas of primary viewing cone 506 and secondary viewing cone 508 may be defined in various manners depending on any number of different design criteria, and are not limited to any specific viewing angles. In addition, as explained in more detail below, the secondary viewing cone may facilitate the view of a single secondary viewing image from within a plurality of viewing angles, or may facilitate a plurality of secondary viewing images, each associated with various of the plurality of viewing angles.

Continuing, the first image suitably comprises a uniform light source, such that the hologram provides substantially uniform, enhanced brightness light to the viewer within the primary viewing angle. Because the light passes through the imaging system 202 to get to the viewer, the image generated by the overall display 200 is the image represented by the imaging system 202. Thus, the illuminating system 204 operates as a backlighting or reflection system for illuminating the information rendered by the imaging system 202 within the primary viewing angle.

The hologram is further configured to present one or more secondary images to viewers outside the primary viewing angle. The hologram can suitably provide 2-dimensional or 3-dimensional images in secondary (or primary) viewing angles. The

secondary image is suitably unrelated to the information presented by the imaging system 202. For example, the secondary image may comprise a logo or constant message to be displayed to viewers within the secondary viewing angle. The secondary image is suitably generated by the hologram, for example in conjunction with conventional hologram technology that allows the hologram to provide one image to a viewer at one angle and a different image to a viewer at another angle. As a result, the view of the information provided by the imaging system 202 tends to be obscured to an observer outside the primary viewing angle; instead, the observer receives the secondary image, such as a company name or logo, which is unrelated to the information presented by the imaging system 202.

Other optical systems may also be implemented to provide the primary and supplemental images. For instance, the illuminating system 204 may comprise a prism sheet or other like material. Referring to Figure 4, the prism sheet 400 suitably comprises multiple reflective, transmissive, or transfective surfaces such that a first set of surfaces 402a-d are substantially parallel to each other, a second set of surfaces 404a-d are substantially parallel to each other, and a third set of surfaces 406a-d are likewise substantially parallel to each other. Though the present illustration includes only three sets of surfaces in only two dimensions, the prism sheet may be configured to include any number of sets of surfaces oriented in any direction.

Each of the sets of surfaces 402, 404, 406 is configured to display a different image. For example, the center set of surfaces 404 may be configured to display a primary image within a primary viewing angle 410 of a white light source, thus providing substantially optimum reflection or transmission of incident light to viewers in the primary viewing angle 410. The outer sets of surfaces 402, 406 may display secondary images. Consequently, viewers outside the primary viewing angle tend to receive the secondary image instead of the primary image.

The illumination system 204 may be configured to provide more than one supplementary image. In accordance with another embodiment, the illuminating system 204 can comprise a plurality of fixed images corresponding to a plurality of secondary viewing angles 208, i.e., a plurality of viewing angles configured in a manner such that the corresponding plurality of secondary viewing images do not to interfere with the viewing by others of the primary viewing image provided by the display system 200. For example, referring again to Figure 2, the illuminating system 204 may include secondary viewing images corresponding to secondary viewing angles 208a and 208b. Moreover, additional viewing angles 208 could be included within the viewing area 203 of the display system 200, such as, for example, the plurality of viewing angles within primary viewing cone 506 and secondary viewing cone 508.

Moreover, in the event that the primary image is not provided, such as if the LCD system is not turned on, the illuminating system 204 may be suitably configured to provide the secondary viewing image to all viewing angles, i.e., the illuminating system 204 can provide a secondary viewing image, such as a fixed image, regardless of the activity of any LCD material within the imaging system 202. Accordingly, the illuminating system 204 may be suitably configured to provide the secondary viewing image continuously regardless of the operation of the imaging system 202, or configured to provide the secondary viewing image only with the operation of the imaging system 202.

Thus, in one example with a plurality of secondary viewing images appropriately configured and placed at secondary viewing angles 208, a viewer may become momentarily positioned at one or more secondary viewing angles 208 in a sequential manner that causes the plurality of secondary images to appear as a single variable image, such as flower opening or a pulsating logo. In the present exemplary embodiments, conventional hologram technology may provide multiple images in a single hologram to generate an appearance of motion or variable imagery. Similarly, multiple related images

may be placed on the various sets of surfaces of a prism sheet to create perceived movement or change as the perspective of the viewer changes.

The illuminating system 204 may be suitably adapted to any available light source. For example, the illumination system may be reflective system, such as a reflective
5 hologram or a reflective prism sheet, configured to redirect light received through the imaging system 202 back through the imaging system 202. Alternatively, the illuminating system 204 may be transmissive, such as a transmissive hologram or transparent prism sheet, configured to transmit light received from behind the illumination system 204 through the imaging system 202 to the viewers. Moreover, the illuminating system 204
10 can comprise a combination of these two features in a transflective system configured to provide both reflection and transmission of a light source through the imaging system 202.

The illuminating system 204 may also provide monochrome images, for example, black and white or gray-scale images, or multi-color images, e.g., red, green, blue or yellow. Moreover, the illuminating system 204 may also be suitably configured to provide
15 full-color images. Accordingly, the illuminating system 204 can provide a primary and secondary images in an array of colors or in a simple monochrome configuration.

The illuminating system 204 may include an attachment mechanism for attaching the illumination system 204 to the imaging system 202. For example, the illumination system may comprise a reflective hologram having an adhesive film 305 for attaching the
20 hologram to the second substrate 306. If a second polarizer 316 is included within the display system 300, the film 305 may be attached directly to the second polarizer 316. Further, the adhesive film 303 could include peel sheets and the like to prevent the adhesive from contacting other surfaces prior to assembly or manufacture. However, in accordance with another exemplary embodiment, the illuminating system 303 could have
25 an adhesive applied, such as, for example, one containing reflective particles and the like, to provide a desired affect, such as a diffusion or other functions.

As discussed above, the display system of the present invention can suitably provide a primary viewing image and a secondary viewing image. Accordingly, such display systems can provide additional alternatives for providing information and pictorials. For example, in a laptop or other small PC application, a user of the system positioned at the primary viewing angle could be observing a primary viewing image, such as various text or graphic messages or pictorial images, while another observer at a secondary viewing angle would see a secondary viewing image, such as promotional bulletins or other commercial advertising. Moreover, in addition to providing security features, a secondary viewing image could provide information concerning the primary viewing angle. For example, the secondary viewing image could provide a text message indicating that the viewer needs to be realigned or repositioned in order to be located in the preferred primary viewing angle.

The present invention has been described above with reference to an exemplary embodiment. However, changes and modifications may be made to the exemplary embodiment without departing from the scope of the present invention. For example, the various substrates, polarizers and other components may be implemented in alternate ways, or comprised of different materials and thicknesses, depending upon the particular application or in consideration of any number of performance criteria associated with the operation of the system. Further, the information content of the secondary and primary images may comprise any text, graphic or pictorial representation and is not limited to those described herein. In addition, the techniques described herein may be extended or modified for use with other modes of displaying in addition to the display system of the exemplary embodiments. These and other changes or modifications are intended to be included within the scope of the present invention, as expressed in the following claims.

CLAIMS

We claim:

1. A display system for providing images to a viewer, said display system
5 comprising:
 an electronic imaging system, and
 an illumination system, wherein said illumination system directs light
through said imaging system to provide simultaneously a primary image in a
primary viewing angle and a secondary image in a secondary viewing angle,
10 wherein the primary image is generated by the electronic imaging system and
the secondary image is a constant image independent from the electronic
imaging system.
2. A display system in accordance with claim 1, wherein said electronic
15 imaging system comprises an LCD display.
3. A display system in accordance with claim 2, wherein said LCD display
comprises
 a first substrate;
20 an LCD material;
 a second substrate disposed adjacent and parallel said first substrate,
and said LCD material being contained between said first substrate and said
second substrate.
- 25 4. A display system in accordance with claim 1, wherein the constant image
is a reflective hologram.
5. A display system in accordance with claim 1, wherein the constant image
is a transmissive hologram.
- 30 6. A display system in accordance with claim 1, wherein the constant image
is a transflective hologram.

7. A display system in accordance with claim 1, wherein said illumination system comprises a prism sheet.

8. A display system for transmitting viewing images, said system
5 comprising:
a first substrate;
an LCD material;
a second substrate disposed adjacent and parallel said first substrate,
said LCD material being contained between said first substrate and said second
10 substrate; and
an illumination system for directing light through said first substrate and
said second substrate to produce simultaneously a primary image within a
primary viewing angle and a secondary image within a secondary viewing
angle, said primary viewing image being a variable image and said secondary
15 image being a constant image independent from the LCD.

9. A display system in accordance with claim 8, wherein said illumination system comprises a hologram for directing light in said primary viewing angle and directing light in said secondary viewing angle.

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10. A method for displaying images to a viewer, said method comprising the steps of:
providing an electronic imaging system for providing a primary image;
directing a light source from an illumination system through said imaging
25 system to provide said primary image in a primary viewing angle, said primary image being a variable image, and
a secondary image in a secondary viewing angle, said secondary image being a constant image independent from the electronic imaging system.

30 11. The method of claim 10, wherein said step of providing a second viewing image in a second viewing angle comprises directing a light source from said illumination system through said imaging system to provide said fixed image.

12. The method of claim 10, wherein said imaging system comprises an LCD display.
- 5 13. The method of claim 11, wherein said illumination system comprises at least one of a hologram and a prism sheet.
14. A display system for displaying images to a viewer comprising:
a first polarizer;
10 a first transparent substrate disposed adjacent and parallel said first polarizer;
an LCD material;
a second transparent substrate being disposed adjacent and parallel said first transparent substrate, said LCD material being contained between said first
15 transparent substrate and said second transparent substrate;
a second polarizer disposed adjacent and parallel said second transparent substrate;
and an illumination device for directing light through said second polarizer, said second substrate, said LCD material, said first substrate and said
20 first polarizer to provide simultaneously a primary viewing image in a primary viewing angle and a secondary viewing image in a secondary viewing angle, said primary viewing image being a variable image as controlled by the activity of the LCD material and said secondary viewing image being a fixed image regardless of the activity of the LCD material.
- 25 15. A display system in accordance with claim 14, wherein said illumination device comprises a hologram.
16. A display system in accordance with claim 15, wherein said hologram
30 comprises a reflective hologram for reflecting a light source back through said second polarizer, said second substrate, said LCD material, said first substrate and said first polarizer.

17. A display system in accordance with claim 15, wherein said hologram comprises a transmissive hologram for allowing light to pass through said hologram such that light is focused and directed through said second polarizer, said second substrate, said LCD material, said first substrate and said first polarizer.

18. A display system in accordance with claim 14, wherein said primary viewing image and said secondary viewing image comprise at least one of a full-color and monochromatic image.

19. A display system in accordance with claim 14, wherein said illumination device comprises a prism sheet.

20. A display system in accordance with claim 7, wherein the prism sheet comprises a first set of surfaces being parallel to each other and at least a second set of surfaces positioned in an angle with respect to said first set of surfaces and being parallel to each other, wherein the first set of surfaces is configured to display said first image and said second set of surfaces is configured to display said second image.

21. The method of claim 13, wherein the prism sheet comprises a first set of surfaces being parallel to each other and at least a second set of surfaces positioned in an angle with respect to said first set of surfaces and being parallel to each other, comprising the further steps of configuring the first set of surfaces to display said first image and configuring said second set of surfaces to display said second image.

22. A display system in accordance with claim 19, wherein the prism sheet comprises a first set of surfaces being parallel to each other and at least a second set of surfaces positioned in an angle with respect to said first set of surfaces and being parallel to each other, wherein the first set of surfaces is

configured to display said first image and said second set of surfaces is configured to display said second image.