the Rayleigh scattering material, textured material, or scattering polarizer behind the screen. This backscattering significantly reduces the contrast of the camera's image, making it more difficult for the vision system to decipher the camera's image.

[0199] If the light is being scattered by a scattering polarizer, the camera is sensitive to near-infrared light, and the illuminator emits near-infrared light, then the aforementioned contrast loss can be reduced through the use of infrared linear polarizers, which linearly polarize infrared light. Placing an infrared linear polarizer in front of the camera, with the polarization direction parallel to the direction at which the scattering polarizer is transparent, will significantly reduce backscatter and improve contrast. Placing an infrared linear polarizer in front of the infrared illuminator, with the polarization direction parallel to the direction at which the scattering polarizer is transparent, will also reduce backscatter and improve contrast.

[0200] Window Display

[0201] According to another aspect of the present invention, the self-contained interactive video displays can be used with a window display. Self-contained interactive video displays can be deployed in a variety of physical configurations, for example, placing the screen horizontal, vertical, or diagonal. However, when deploying such a display on a window, there are several additional possible physical configurations.

[0202] **FIG. 22** illustrates an exemplary configuration of an interactive window display **2200**, in accordance with an embodiment of the present invention. In one embodiment, instead of being self-contained, the components can be physically separated. The screen **2210** can be affixed directly to the window **2220** surface or mounted separately behind the window **2220**. The camera **2230**, projector **2240**, and illuminators **2250** can be placed either in nearby or separate locations, and may be mounted on the floor, ceiling, or anywhere in between at various distances from the window **2220**. Optionally, the infrared illuminators **2250** can be placed to the side of the screen **2210** so that they shine directly onto the subject instead of through the screen **2210**. Also optionally, the communication between the camera **2230** and computer **2260**, or between the computer **2260** and projector **2240**, may be wireless.

[0203] The camera in window displays is generally aimed horizontally. Consequently, the camera usually views people at an arbitrary distance from the screen. While the vision software, screen material, or other systems can be used to identify and remove objects at an excessive distance, it is also possible to tilt the camera upwards so that more distant objects may need to be of a certain minimum height in order for the camera to see them. Thus, only people within a few feet of the screen are able to interact with it. Users approaching such a display will notice their virtual presence first appear at the bottom of the screen and then gradually rise up as they come closer to the screen. **FIG. 22** shows a camera **2230** tilted upward in this manner.

[0204] Glare is an issue in window displays. However, users of a window display are limited in the angles that they typically to view the screen. They will be unlikely to look at the screen from an oblique angle in general because they will probably maintain a distance of at least a few (e.g., two) feet from the display so as to have room to point at objects on the display with their arms and hands. For a display at and below eye level, people are especially unlikely to look up at the display from an oblique angle. If the projector is placed extremely close to the screen but above the top of the screen, with its beam projecting downward at an oblique angle, then this low-glare situation will be realized. Alternatively, if the display is set up to be at or above eye level, then a similar glare reduction can be achieved by placing the projector below and close to the screen, projecting upward at an oblique angle. Note that off-axis projectors are especially useful for these sorts of configurations.

[0205] Window Unit: Alternative Configuration

[0206] Visible-light transparency of the screen is more desirable in a window unit than in a self-contained unit. Thus, window displays can be built with a partially transparent screen that is translucent to light that is shined on it at a particular angle. One material that can be used to build the partially transparent screen is marketed under the trade name "HoloClear" and manufactured by Dai Nippon Printing; such material is translucent to light shined onto it at a 35 degree angle. This screen takes the place of the IR-transparent VIS-translucent screen or the scattering polarizer screen. If the projector shines light onto the screen from that angle, then there will be no glare from the projector. As long as the camera is at a significantly different angle (to the screen) from the projector, the system will be able to function properly.

[0207] Interface to Window Unit

[0208] The interface to the window unit can be made distance-dependent with the same methods as the self-contained unit, including the use of stereo cameras, time-of-flight cameras, and the techniques described in the "Touchscreen" sections of this patent. In one embodiment, the interactions with the window unit include a mix of full-body interactions and more precise gestures, such as pointing.

[0209] With a vision system that extracts depth information, it is possible to isolate pointing gestures and other hand motions through several methods. First, the camera image can be divided up into distance ranges, with one distance range for full-body interaction and another (presumably closer) distance range for pointing gestures. The objects in the latter distance range would be tracked as pointers, with their locations serving as input to the application running on the display. Alternatively, all objects less than a particular distance from the screen could be analyzed to find the point within them that is closest to the screen. If that point is closer to the screen from the rest of the object by at least a particular threshold, then it could become an input for pointing gestures. Visual feedback on the screen could be provided to show the position of any detected hand motions.

[0210] Techniques for Reducing Glare

[0211] If it can be ensured that the viewer always sees the projector glare from a specific range of angles, then the glare can be further reduced without adversely affecting the camera's view of the scene. **FIGS. 23A, 23B** and **23**C are simplified schematic diagrams respectively illustrating various techniques for reducing glare in accordance with different embodiments of the present invention. **FIG. 23A** illustrates a pleated screen material. Suppose that the screen is pleated so that a light ray coming from an oblique angle would have to go through several layers of screen, while a light ray coming close to straight through would usually only go through one layer. If the projector's light comes from an oblique angle while the camera views the screen closer to parallel, then the amount of scattering of the