

ment panel, steering wheel or at some other convenient location, allows the driver to select the amount of darkening accomplished by the system from no darkening to maximum darkening. In this manner, the driver can select the amount of light that is filtered to suit his particular physiology. The sensor 410 can either be designed to respond to a single light source or to multiple light sources to be sensed and thus multiple portions of the vehicle windshield to be darkened.

[0244] As an alternative to locating the direction of the offending light source, a camera looking at the eyes of the driver can determine when they are being subjected to glare and then impose a filter, perhaps by a trail and error calculation or through the use of structured light created by a pattern on the windshield, determines where to create the filter to block the glare.

[0245] More efficient systems are now becoming available to permit a substantial cost reduction as well as higher speed selective darkening of the windshield for glare control. These systems permit covering the entire windshield which is difficult to achieve with LCDs. For example, such systems are made from thin sheets of plastic film, sometimes with an entrapped liquid, and can usually be sandwiched between the two pieces of glass that make up a typical windshield. The development of conductive plastics permits the addressing and thus the manipulation of pixels of a transparent film that heretofore was not possible. These new technologies will now be discussed.

[0246] If the objective is for glare control then the Xerox Gyricon technology applied to windows is appropriate. Heretofore this technology has only been used to make e-paper and a modification to the technology is necessary for it to work for glare control. Gyricon is a thin layer of transparent plastic full of millions of small black and white or red and white beads, like toner particles. The beads are contained in an oil-filled cavity. When voltage is applied, the beads rotate to present a colored side to the viewer. The advantages of Gyricon are: (1) it is electrically writeable and erasable; (2) it can be re-used thousands of times; (3) it does not require backlighting or refreshing; (4) it is brighter than today's reflective displays; and, (5) it operates on low power. The changes required are to cause the colored spheres to rotate 90 degrees rather than 180 degrees and to make half of each sphere transparent so that the display switches from opaque to 50% transparent.

[0247] Another technology, SPD light control technology from Research Frontiers Inc., has been used to darken entire windows but not as a system for darkening only a portion of the glass or sun visor to impose a selective filter to block the sun or headlights of an oncoming vehicle. Although it has been used as a display for laptop computers, it has not been used as a heads-up display (HUD) replacement technology for automobile or truck windshields.

[0248] Both SPD and Gyricon technologies require that the particles be immersed in a fluid so that the particles can move. Since the properties of the fluid will be temperature sensitive, these technologies will vary somewhat in performance over the automotive temperature range. The preferred technology, therefore, is plastic electronics although in many applications either Gyricon or SPD will also be used in combination with plastic electronics, at least until the technology matures.

[0249] The calculations of the location of the driver's eyes using acoustic systems may be in error and therefore pro-

vision must be made to correct for this error. One such system permits the driver to adjust the center of the darkened portion of the windshield to correct for such errors through a knob, mouse pad, joy stick or other input device, on the instrument panel, steering wheel, door, armrest or other convenient location. Another solution permits the driver to make the adjustment by slightly moving his head. Once a calculation as to the location of the driver's eyes has been made, that calculation is not changed even though the driver moves his head slightly. It is assumed that the driver will only move his head to center the darkened portion of the windshield to optimally filter the light from the oncoming vehicle. The monitoring system will detect this initial head motion and make the correction automatically for future calculations. Additionally, a camera observing the driver or other occupant can monitor the reflections of the sun or an oncoming vehicles headlights off of the occupant's head or eyes and automatically adjust the filter in the windshield or sun visor.

[0250] Electro-chromic glass is currently used in rear view mirrors to darken the entire mirror in response to the amount of light striking an associated sensor. This substantially reduces the ability of the driver to see objects coming from behind his vehicle. If one rear-approaching vehicle, for example, has failed to dim his lights, the mirror will be darkened to respond to the light from that vehicle making it difficult for the driver to see other vehicles that are also approaching from the rear. If the rear view mirror is selectively darkened on only those portions that cover the lights from the offending vehicle, the driver is able to see all of the light coming from the rear whether the source is bright or dim. This permits the driver to see all of the approaching vehicles not just the one with bright lights.

[0251] Such a system is illustrated in FIG. 1212A and 12B where rear view mirror 460 is equipped with electrochromic glass, or comprises a liquid crystal or similar device, having the capability of being selectively darkened, e.g., at area 419. Associated with mirror 460 is a light sensor 462 that determines the direction of light 412 from the headlights of rear approaching vehicle 405. In the same manner as above, transducers 231, 232 and 233 determine the location of the eyes of the driver 210. The signals from both sensor systems, 231, 232 plus 233 and 462, are combined in processor 101, where a determination is made as to what portions of the mirror should be darkened, e.g., area 419. Appropriate currents are then sent to the mirror in a manner similar to the windshield system described above. Again, an alternative solution is to observe a glare reflection on the face of the driver and remove the glare with a filter.

[0252] Note, the rearview mirror is also an appropriate place to display icons of the contents of the blind spot or other areas surrounding the vehicle as disclosed in U.S. patent application Ser. No. 09/851,362 filed May 8, 2001 and incorporated herein by reference.

[0253] 7. Window Displays

[0254] In addition to offering the possibility of glare control, plastic electronics offer the possibility of turning any window into a display. This can be the windshield of an automobile or any window in a vehicle or house or other building, for that matter. A storefront can become a changeable advertising display, for example, and the windows of a house could be a display where emergency services warn