liquid crystal displays (LCD), light emitting diode (LED) displays, electroluminescent displays (ELD), plasma displays, and static graphics displays to control the direction of the display light. In these systems, the touch sensor is arranged so that the display is viewable through the touch sensor.

[0020] Light control touch sensors may be particularly useful in applications where privacy viewing is desired or required, such as a publicly located ATM. In these applications the touch sensor with light control reduces the viewing angle of the display. The line of sight of an unauthorized observer is blocked by the light control touch sensor, allowing the user to conduct a private transaction at a public terminal.

[0021] The touch sensor with light control may also be used to enhance the readability of a touch sensing system by blocking off-axis light. For example, light control may be used to improve display readability during periods of direct sunlight or light source reflections. The light control blocks off-axis light while improving the light transmission from the display to the user. Furthermore, reducing off-axis light decreases glare and improves nighttime viewing by decreasing ambient light source reflections. Any suitable light control elements can be used in the present invention. Exemplary light control devices include those disclosed in U.S. Pat. Nos. 4,764,410; 5,147,716; 5,204,160; 5,254,388; and 6,398,370.

[0022] The present invention relates to the incorporation of a light control function into a structural element of a touch sensor. For the purposes of this document, a structural element of a touch sensor is an element that provides support for one or more other elements of the touch sensor, and is an element that if removed would result in a touch sensor that no longer functions. For example, a substrate onto which is deposited transparent conductive layer for sensing touch inputs would be considered a structural element. Other instances will be discussed in the context of certain touch technologies. The structural element may or may not provide the touch surface of the touch sensor.

[0023] Turning now to **FIG. 1**, there is shown an embodiment of a touch sensing system **100** using a touch sensor with light control in accordance with an embodiment of the present invention. The touch sensing system **100** shown in **FIG. 1** includes a touch sensor **110** that is communicatively coupled to a controller **130**. In a typical configuration, the touch sensor **110** is used in combination with a display **120** of a computer system **140** to provide for visual and tactile interaction between a user and the computer system **140**. The touch sensor **110** and the display **120** may be arranged so that the display **120** is viewable through the touch sensor **110**.

[0024] The touch sensor **110** can be implemented as a device separate from, but operative with, the display **120** of the computer system **140**. Alternatively, the touch sensor **110** can be implemented as part of a unitary system which includes a display device, such as a plasma, LCD, or other type of display technology amenable to incorporation of the touch sensor **110**. It is further understood that the touch sensor **110** may be implemented as a component of a system defined to include only the touch sensor **110** and the controller **130** which, together, can implement a light control touch sensing methodology of the present invention.

[0025] In the illustrative configuration shown in **FIG. 1**, communication between the touch sensor **110** and the computer system **140** is implemented via the controller **130**. The controller **130** is typically configured to execute firmware/software that provides for detection of touches applied to the touch sensor **110**. The controller **130** may alternatively be arranged as a component of the computer system **140**.

[0026] A touch sensing method in accordance with one embodiment of the invention is illustrated in the flowchart of **FIG. 2**. The method involves providing **210** an optical control layer as a structural element of a touch sensor. The direction of light through the touch sensor is controlled **220** using the optical control layer. In one embodiment, a micro-louvered film is used as the light control layer. The micro-louvered film may be implemented, for example, as a thin layer comprising a series of closely spaced opaque micro-louvers to shield out unwanted light and direct the light of a display through the touch sensor.

[0027] Implementation of light control in accordance with embodiments of the invention is illustrated in the diagrams of **FIGS. 3 and 4**. **FIG. 3** illustrates the use of a touch screen with light control to enhance the readability of a display viewable through the touch sensor. A touch sensor **305** having a light control film **310**, such as a micro-louvered film, is arranged between an electro-optical display **320** and a user **330**. An ambient light source **340** produces off-axis light that is blocked by the light control film **310**. The touch sensor **305** with light control is interposed between the electro-optical display **320** and the user **330**. This configuration enhances the readability of the electro-optical display **320** by reducing glare caused by off-axis ambient light source **340**.

[0028] **FIG. 4** illustrates the use of a touch screen with light control to provide privacy viewing of a display. In this implementation, a touch sensor **405** incorporating a light control film **410**, e.g., a micro-louvered film, is interposed between a user **430** and a display **420**. The presence of the micro-louvered film limits the viewing angle of the display by providing a physical barrier to the light with respect to an unauthorized observer **440** positioned at an angle to the touch sensor and the display. Light from the display **420** passes through the touch sensor's light control film **410** which operates to block the view of the unauthorized observer **440**. The user **430** is positioned so that light from the display **420** is directed to the user **430**.

[0029] A light control touch sensor in accordance with an embodiment of the invention may employ a resistive touch sensing technology. One configuration of a resistive touch sensor with light control is illustrated in the diagram of **FIG. 5**. In this implementation, at least one of the structural elements of the resistive touch sensor includes a light control function, for example a micro-louvered light control film.

[0030] A resistive touch sensor is energized by the application of a drive signal from a controller to one or more of conductive layers of the resistive touch sensor. A touch applied to the surface of the resistive touch sensor deflects a first flexible, conductive layer, causing the first conductive layer to make contact with a second conductive layer. Contact between the first and second conductive layers causes a change in a sensed electrical signal. The location of the touch is determined as a function of the point of contact between the conductive layers.