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TOUCH SENSITIVE DEVICE

This invention relates to a touch sensitive device, and more particularly to such a device for use with a synchronized light source, such as a cathode ray tube (CRT), for automatically identifying the location of a touched portion of the device.

Touch sensitive devices are generally known. One such device uses a rigid, transparent member overlying the raster of a scanning type display device. Light from the raster normally passes through the member to a viewer. When a portion of the member is touched, however, light is backwardly reflected into and along the member to a light detector. Because the displayed image is written by a scanning process, the time of occurrence of the light detection during each scanning cycle identifies the exact position of the writing means, hence the location of the touch on the display device raster. In a variation from such arrangement, a flexible member is used overlying the transparent member to increase the amount of light reflected into the member.

A problem with such known devices, however, is that owing to the relatively small amount of light reflected in response to the touch, only a weak signal reaches the light detector, thereby making difficult proper recognition of the light signal.

According to the present invention there is provided a touch sensitive device for use in

conjunction with a signal source, said device comprising spaced apart surfaces arranged such that signals are introduced between said surfaces so as to become entrapped within said device by total internal reflection ^{at} ~~between~~ said surfaces as a result of a deformation of one of said surfaces of said device relative to the other of said surfaces, as a result of said one surface being touched, and signal utilization means adapted to provide a distinctive output when said signals are so introduced between said surfaces.

An exemplary embodiment of the invention will now be described, reference being made to the accompanying drawings, in which:

FIG. 1 shows a CRT screen overlaid by a touch sensitive device in accordance with the present invention; and

FIGS. 2 and 3 are schematic representations showing the arrangement of FIG. 1 in untouched and touched conditions, respectively.

As shown in FIG 1, a touch sensitive device is shown in use with a cathode ray tube (CRT) 20 on which images are displayed (in known fashion) by a line-by-line scanning of the screen of the tube by an electron beam. The CRT screen is overlaid with a soft, or compliant, transparent member 10 having substantially parallel surfaces through which light from the phosphorescent screen may pass. Disposed between the CRT screen and the member 10 is a transparent spacer member, e.g. a mesh 31, the mesh 31 defining an air gap 30 between the member 10 and the screen of the CRT. The index of refraction of member 10 is greater than that of air. Details of the member 10 and the mesh 31 are provided hereinafter.

When a finger or other device is placed against device 10 at the position selected (e.g., the number 6 in FIG. 1), the outer surface of member 10 deforms and light becomes trapped within it. This trapped light

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travels to the edge of the member 10 and is detected by photodiodes 101 thereby providing an output signal useable for determining the position of the touch. The actual determination of the touch position is accomplished by determining the position of the electron beam at the time of the output signal. Means for doing this are known, e.g., see U.S. Patent No. 4,305,071. Many different known types of signal detectors can be used, some not even physically connected to member 10, to determine whether or not light has been trapped.

Turning to FIG. 2, the CRT electron beam 13 is shown impinging on the front surface of CRT 20 with light rays 21 from the phosphorescent surface passing through the air gap 30 defined by the mesh 31 and into the parallel surfaces 14 and 15 of member 10 and out into air. Most of the light rays are transmitted outward toward the user. Because the index of refraction of member 10 is greater than that of the air on either side thereof, some of the light rays are reflected back each time the light rays reach a surface boundary. However, most of the rays are traveling in a direction nearly perpendicular to the surface so that it takes many reflections for the rays to reach the detectors 101 and most of the reflected light is lost. While a signal is thus generated by the photodiodes 101 in response to this internally scattered light, the signal is relatively weak.

In FIG. 3, a finger is shown touching upper surface 14 of member 10. This touch, as shown, causes a deformation in the outer surface, which changes the geometry of the inner structure of member 10 by creating an inwardly curving surface 32. This curving surface then serves to both scatter and back reflect the light incident thereon. Mesh 31 prevents contact between member 10 and the CRT, thus maintaining the air gap therebetween, whereby the backwardly directed light rays tend not to re-enter the CRT.

Some of the light rays, such as ray 33, are reflected with an angle of reflection greater than the critical angle. They thus remain trapped within the surfaces of member 10, and eventually impinge upon the photodiodes 101 giving an output signal which is greater than the ambient scattered light signal. Details concerning the significance of the critical angle of light reflection with respect to light trapping and light guiding through a transparent member are known (see, for example, U.S. Patent No. 4,346,376).

The mesh 31 is not essential for the operation of the device and can be omitted. However, as described, it is effective to reduce loss of the backwardly directed light, hence is preferably used to increase the amount of light trapped in response to the touch.

The improvement provided by the invention is as follows. With the rigid plate of the prior art, the amount of backwardly directed light is dependent upon the size of the touched spot and the light reflectivity of the touching object, e.g., the user's finger. Both of these factors are quite variable. For example, the light reflectivity is dependent, to some extent, upon the wetness of the user's finger and upon the size and thickness of the film of moisture thereby deposited on the touched surface.

With the compliant member 10 of this invention, the curved surface 32 resulting from the touch provides a much larger reflecting surface, as compared to that provided in the rigid plate system, and the curvature of the surface 32 greatly increases the amount of light backwardly directed into and along the member 10. Taken together, these factors greatly increase the amount of light trapped by the member 10 in response to a touch.

The compliant member 10 can be of any soft, easily deformed, light transparent and light

transmitting material, e.g., a known thermoplastic material such as a known silicone elastomer, of which there are a large variety. An example of a suitable material is the silicone elastomer designated

5 "Sylgard 184" resin and sold by the Dow Corning Co. of U.S.A. This material has a refractive index of around 1.5 and can be formulated in a quite soft and compliant condition, e.g., having a durometer hardness (Shore A meter) of 20 and less. The

10 thickness of the member 10 is not critical, thicknesses between 3 and 6 mm being typical.

The mesh 31 can be of a variety of known transparent screen or cloth-like materials of the type known for use in industrial screening and filtering

15 applications. Examples of suitable meshes are described in the General Catalog No. 2000 from Tetko, Inc., Elmsford, New York, U.S.A. A relatively large mesh opening is used, to provide light transparency, and preferably, a black color is used

20 to improve the image contrast by reducing light reflection caused by any ambient lighting. Also, if the light source is a CRT or similar device, the mesh 31 is preferably electrically conducting to provide electrostatic shielding of the face plate of

25 the CRT. Such electrical conductivity can be provided by the use of metallic fibers in the mesh 31 or the use of an electrically conductive coating thereon. Etched metallic films can also be used for the mesh 31.

30 An exemplary mesh has the following characteristics: material-carbonized nylon thread; thread diameter - 53 microns; mesh weight - 22.4 grams per square yard; weave pattern-square; mesh count - 145 mesh; nominal opening - 130 microns; percent

35 open area - 49%.

Though, in this embodiment of the invention, arrows have been shown on light rays to indicate a

38 particular direction of propagation, light paths are

always reversible, and thus a dual of the device described here can be constructed by replacing the scanned display screen with a scanned photodetector array.

5 It is to be understood that although in the embodiment described the signals used have been light signals, they may alternatively be acoustical or may be electronic so long as they obey the physical phenomenon described. It, of course, is to
10 be understood that those skilled in the art may find many applications and modifications of the principles described and it is envisaged that the touch sensitive device described may be built as a separate device for mating with an existing CRT or it may be
15 manufactured as a part of the CRT implosion shield itself. Also, it should be noted that because the amount of deformation of the top surface is a function of the pressure applied, and since the larger the deformation, the greater will be the amount of
20 light trapped, it is possible to construct a device which detects the applied force, or which uses this force to select, for example, colors or hues, in a graphical environment.

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CLAIMS

1. A touch sensitive device for use in conjunction with a signal source, said device comprising spaced apart surfaces arranged such that signals are introduced between said surfaces so as to become entrapped within said device by total internal reflection ^{at} ~~between~~ said surfaces as a result of a deformation of one of said surfaces of said device relative to the other of said surfaces as a result of said one surface being touched, and signal utilization means adapted to provide a distinctive output when said signals are so introduced between said surfaces.
2. A device as claimed in claim 1, wherein a portion of said signals pass through said surfaces.
3. A device as claimed in claim 1, wherein said surfaces are substantially parallel to each other prior to said touch and wherein the inner side of said deformed surface forms a convex surface with respect to said signals.
4. A device as claimed in any preceding claim, further comprising means for coordinating the position of said signal across said surfaces of said device with said distinctive output to determine the exact position on said surface of said touch.
5. A device as claimed in any preceding claim, wherein said signal source is a cathode ray tube and wherein said signals which are introduced into said device are light signals from said cathode ray tube.
6. A device as claimed in claim 5, wherein spacer means is provided positioned between said device and said cathode ray tube to ensure the presence of an air gap even when said surface is touched.
7. A device as claimed in claim 6, wherein the spacer means comprises a transparent mesh.
8. A device as claimed in claim 6 or claim 7, wherein the spacer means is electrically conductive.
9. A device as claimed in any of claims 5 to 8, wherein said signal utilisation means includes at least



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one light detecting diode.

10. A touch sensitive device substantially as hereinbefore described with reference to the accompanying drawings.

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