Title: PHOTOSENSOR, TARGET DETECTION METHOD AND DISPLAY PANEL

Abstract: A photosensor includes first and second light receiving elements (12, 16, 18) which detect light, and a light source which is disposed behind the first and second light receiving elements and which emits light containing a predetermined color component. A first filter (102) is disposed in front of the first light receiving element and transmits light of the predetermined color component, and a second filter (104) is disposed in front of the second light receiving element and shuts off the light of the predetermined color component and transmits a color component other than the predetermined color component. A judging section judges whether or not a detection target is present in front of the first (102) and second filters (104) in accordance with outputs from the first and second light receiving elements (12, 16, 18).
DESCRIPTION

PHOTOSENSOR, TARGET DETECTION METHOD AND DISPLAY PANEL

Technical Field

The present invention relates to a photosensor for detecting light, a target detection method of the photosensor, and a display panel equipped with the photosensor.

Background Art

As disclosed in, for example, Jpn. Pat. Appln. KOKAI Publication No. 6-236980, there has hitherto been known a photosensor constituted of a plurality of adjacently arranged light receiving elements formed from amorphous silicon (hereinafter referred to as a-Si) as thin-film transistors (hereinafter referred to as a-Si TFTs), which produce electrical energy-corresponding to irradiated light.

FIG. 7 is a diagram showing one example of the light-electricity characteristics of an a-Si TFT used in such a photosensor. (Ids [A] is measured when the illumination of irradiated light is used as a parameter under conditions such that TFT size (W/L) = 180000/9 µm, and terminal voltages Vs = 0 V and Vd = 10 V). FIG. 7 shows that the drain-source current Ids increases with illumination. The Ids prominently increases especially in a reverse bias region (Vgs<0),
and the photosensor generally uses the characteristic of this region to detect the illumination of the irradiated light as the change of the IDs.

Such a photosensor (light detector) is used to detect the presence of, for example, a pachinko ball (pinball) or paper as a detection target (e.g., Jpn. Pat. Appln. KOKAI Publication No. 2002-148353).

However, in such an application, there is a high possibility of disturbance light entering the light receiving element in addition to light radiated from a light source and reflected by the detection target. If the disturbance light enters the light receiving element, an erroneous operation may be caused due to decreased accuracy in the detection of the detection target.

Thus, Jpn. Pat. Appln. KOKAI Publication No. 2002-148353 has proposed a detection method in which the light emission timing of a light emitting element for emitting light to be applied to a detection target is compared with the light receiving timing of a light receiving element, and in which it is recognized whether light reflected from the detection target or outside light has been received in accordance with whether these timings are synchronized with each other.

However, the detection method disclosed in Jpn. Pat. Appln. KOKAI Publication No. 2002-148353 is not capable of providing an inexpensive photosensor free of
erroneous operations due to a complicated detection circuit, the necessity of strict timing control, etc.

Disclosure of Invention

The present invention has been made in view of the foregoing, and an object of the present invention is to provide a photosensor which requires no complicated detection circuit and no strict timing control, as well as to provide a target detection method of the photosensor, and a display panel equipped with the photosensor.

According to one aspect of the invention, a photosensor includes: first and second light receiving elements which detect light; a light source which is disposed behind the first and second light receiving elements and which emits light containing a predetermined color component; a first filter which is disposed in front of the first light receiving element and which transmits light of the predetermined color component; a second filter which is disposed in front of the second light receiving element and which shuts off the light of the predetermined color component and transmits a color component other than the predetermined color component; and judging means for judging whether or not a detection target is present in front of the first and second filters based on outputs from the first and second light receiving elements.

According to another aspect of the present
invention, a method is provided for controlling the photosensor panel to judge whether or not the detection target is present.

According to a further aspect of the present invention, a display panel is provided which includes the photosensor. The photosensor may be provided as an operating switch to control a display element of the display panel.

According to the present invention, it is possible to provide a photosensor which requires no complicated detection circuit and no strict timing control, a target detection method of the photosensor, and a display panel equipped with the photosensor.

Brief Description of Drawings

FIG. 1A is a diagram showing an example of the configuration of a photosensor according to a first embodiment of the present invention;

FIG. 1B is a diagram for explaining the path of light when a detection target contacts an opposite substrate;

FIG. 1C is a diagram for explaining the path of light when strong outside light has entered the photosensor;

FIG. 2 is a schematic diagram for explaining the operation of the photosensor according to the first embodiment;

FIG. 3 is a diagram showing a TFT-LCD panel
integrally incorporating a plurality of photosensors according to the first embodiment;

FIG. 4 is a diagram showing the electrical connection and configuration of the TFTs of a
5 photosensor;

FIG. 5 is a diagram of a detection circuit built in a sensor LSI;

FIG. 6 is a diagram showing an example of the configuration of a photosensor according to a second
10 embodiment of the present invention; and

FIG. 7 is a diagram showing the light-elektricity characteristics of an a-Si TFT.

Best Mode for Carrying Out the Invention

A best mode of carrying out the present invention will hereinafter be described with reference to the
drawings.

[First Embodiment]

FIG. IA is a diagram showing an example of the configuration of a photosensor according to a first
20 embodiment of the present invention. For simplicity, only two a-Si TFTs are shown as light receiving
elements in the photosensor in FIG. IA.

The a-Si TFT as the light receiving element includes a gate electrode 12 formed on a transparent TFT substrate 10, a transparent insulating film 14 formed on the gate electrode 12, an a-Si part 16 formed opposite to the gate electrode 12 on the insulating
film 14, and source and drain electrodes 18 formed on the a-Si part 16. In addition, the transparent insulating film 14 is formed on the upper side (front side) of the a-Si TFT.

Moreover, a transparent opposite substrate 20 is provided on the upper side (front side) of the insulating film 14 as shown in FIG. 1A so that a predetermined distance between the insulating film 14 and the transparent opposite substrate 20 is secured by a seal member and a gap member (not shown). The predetermined distance is decided in accordance with the space between the adjacently disposed a-Si TFTs and in accordance with the refractive indices of the members constituting the photosensor. That is, the predetermined distance is decided so that the a-Si part 16 of each of the a-Si TFTs can correctly receive reflected light 26, which is a backlight ray that is radiated from a white backlight 19 disposed on the back side of the TFT substrate 10 to the side of the opposite substrate 20 through a space between the adjacent a-Si TFTs and which is reflected by a detection target such as a finger 24 placed on the opposite substrate 20.

The predetermined distance between the insulating film 14 and the transparent opposite substrate 20 may be filled with air as a space, or liquid crystal may be filled therein when the photosensors are formed so that
they are integrally incorporated in a TFT-LCD panel as described later.

In the photosensor according to the present embodiment, a color filter for transmitting light of a particular wavelength region, here a red color filter (hereinafter referred to as a TFT R filter) 100 for transmitting light of a red wavelength is formed on the lower surface (white backlight side) of the transparent TFT substrate 10. Below, the "particular wavelength region" refers to the red wavelength region, or the red light that is transmitted by the TFT R filter 100. In addition, on the lower surface (a-Si TFT side) of the transparent opposite substrate 20, a red color filter (hereinafter referred to as an opposite R filter) 102 for transmitting light of a red wavelength (i.e., light in the particular wavelength region), and a color filter for shutting off the light of the particular wavelength region, here, a green color filter (hereinafter referred to as an opposite G filter) 104 for transmitting light of a green wavelength, are formed. The opposite R filter 102 is formed opposite to one of the adjacently arranged a-Si TFTs, and the opposite G filter 104 is formed opposite to the other of the adjacently arranged a-Si TFTs. Moreover, a black mask 106 made of a light absorbing material such as a resin or Cr oxide is formed between the opposite R filter 102 and the opposite G filter 104. The color
filters 100, 102 and 104, as well as the black mask 106, are formed by a semiconductor process.

Thus, the photosensor according to the present embodiment includes at least two a-Si TFTs as first and second light receiving elements for light detection, the TFT R filter 100 which is disposed on the back sides of the two a-Si TFTs and which only allows a red backlight ray as a predetermined color component to exit from the back sides to front sides of the light receiving elements, the opposite R filter 102 which is disposed on the front side of one of the two a-Si TFTs and which only transmits red light, and the opposite G filter 104 which is disposed on the front side of the other of the two a-Si TFTs and which shuts off the red light and transmits green light. Further, the two a-Si TFTs are adjacently arranged with a predetermined space in between them so that the light from the backlight can pass therebetween. In addition, a light source is constituted by the white backlight 19 and the TFT R filter 100.

Next, the operation of the photosensor having such a configuration will be described with reference to FIG. 1B, FIG. 1C and FIG. 2. FIG. 1B is a diagram for explaining the path of the backlight ray when the finger 24 as a detection target contacts the opposite substrate 20, and FIG. 1C is a diagram for explaining the path of light when strong outside light 28 has
entered. Moreover, FIG. 2 is a schematic diagram for explaining the operation of the photosensor of the present embodiment.

In the present embodiment, as shown in FIG. 1B, a red component 22R alone is selected by the TFT R filter 100 from the backlight ray generated from the white backlight 19, and the backlight ray then passes between the adjacent a-Si TFTs and is radiated toward the opposite substrate 20.

In a region where the opposite R filter 102 is formed, the red component 22R of the backlight ray penetrates through the opposite substrate 20 and the opposite R filter 102, and exits to the outside of the photosensor. Then, the backlight ray is reflected by the finger 24 as the detection target contacting the top of the opposite substrate 20, and the reflected backlight ray is returned into the photosensor as red reflected light 26R. This red reflected light 26R penetrates through the opposite substrate 20 and the opposite R filter 102, and is applied to the a-Si TFT disposed under the opposite R filter 102.

On the other hand, in a region where the opposite G filter 104 is formed, the red component 22R of the backlight ray is absorbed or diffusely reflected by the opposite G filter 104 so that it is mostly shut off without exiting to the outside of the photosensor. Then, even if a portion of the red component 22R of the
backlight ray which has slightly exited to the outside through the opposite G filter 104 is reflected by the finger 24, thereby obtaining red reflected light 26R, most of the red reflected light 26R is shut off by the opposite G filter 104. See FIG. IB. Consequently, almost no red light is applied to the a-Si TFT disposed under the opposite G filter 104.

Therefore, when the finger 24 is in contact with the photosensor (when the detection target covers the front sides of the opposite R filter 102 and the opposite G filter 104), a situation arises where the a-Si TFT (TFT 1) under the opposite R filter 102 receives light reflected from the detection target while the a-Si TFT (TFT 2) under the opposite G filter 104 does not receive the light reflected from the detection target, as shown in the left portion of FIG. 2. That is, a situation arises where the a-Si TFT (TFT 1) corresponding to the opposite R filter 102 receives light having an intensity equal to or more than a predetermined first threshold value while the a-Si TFT (TFT 2) corresponding to the opposite G filter 104 receives light having an intensity below a predetermined second threshold value. In the present embodiment, this situation is referred to as the photosensor being on (a condition where the detection target is present).

On the other hand, when the outside light 28 such
as sunlight having a luminance higher than that of the backlight ray is applied to the photosensor as shown in FIG. 1C, the a-Si TFT under the opposite R filter 102 receives a red component 28R of the outside light, and the a-Si TFT under the G filter receives a green component 28G of the outside light. That is, as shown in the right portion of FIG. 2, a situation arises where the adjacent a-Si TFTs receive light having an intensity equal to or more than the predetermined first threshold value or the predetermined second threshold value. In the present embodiment, this situation is referred to as the photosensor being off (a condition where the detection target is absent).

In the present embodiment, a situation where the luminance of the outside light 28 is low and both of the adjacent a-Si TFTs receive no light as shown in the center of FIG. 2 is also referred to as the photosensor being off (a condition where the detection target is absent). That is, the present embodiment also refers to a situation where the adjacent a-Si TFTs receive light having an intensity below the predetermined first threshold value or the predetermined second threshold value as the photosensor being off (a condition where the detection target is absent).

The principle described above makes it possible to provide a mechanism in which only a condition where the finger 24 is in contact with the photosensor is
recognized as being an "on" condition of the photosensor (a condition where the detection target is present) while other conditions are recognized as being an "off" condition of the photosensor (a condition where the detection target is absent).

In the present embodiment, light emitting means for emitting light of a particular wavelength region is constituted by the white backlight 19 as a white light source disposed on the lower side of the transparent TFT substrate 10 and the red color filter (TFT R filter) 100 as a third filter for selecting a predetermined color component from the white light emitted from the white backlight and transmitting the predetermined color component.

Furthermore, irradiating light selecting means for selectively transmitting the light emitted from the light emitting means to a detection target is constituted by the red color filter (opposite R filter) 102 as a first filter which transmits the light emitted from the light emitting means, and the green color filter (opposite G filter) 104 as a second filter which has a transparent wavelength region different from the particular wavelength region and which does not transmit the light emitted from the light emitting means.

Moreover, a light receiving element array is constituted by a plurality of light receiving elements
including the a-Si TFT (TFT 1) disposed under the opposite R filter 102 as a first light receiving element for receiving light transmitted through the first filter and the a-Si TFT (TFT 2) disposed under the opposite G filter 104 as a second light receiving element for receiving light transmitted through the second filter. Thus, a photosensor is provided which judges by unshown judging means whether the detection target is present as described above in accordance with the output from the light receiving element array.

As described above, according to the present embodiment, only the condition where the finger 24 is in contact with the photosensor is recognized as the photosensor being on (a condition where the detection target is present), while the case of strong disturbance light and the case of no disturbance or reflected light are recognized as the photosensor being off, whereby the photosensor of the first embodiment is able to avoid incorrectly detecting the presence of the detection object.

FIG. 3 is a diagram showing an example in which a plurality of photosensors are formed to be integrally incorporated into a TFT-LCD panel as a display element for indicating information. In this case, the photosensors function as operating switches for controlling the state of the TFT-LCD panel. That is, the photosensors function as, for example, an operating
switch(es) for switching on or off the power of the TFT-LCD panel and an operating switch(es) for switching indicated contents displayed on the TFT-LCD panel.

Furthermore, FIG. 4 is a diagram showing the electrical connection and configuration of the a-Si TFTs, and FIG. 5 is a diagram of a detection circuit built in a sensor LSI.

A TFT-LCD panel 108 has a TFT-LCD 112 and an LCD drive LSI 114 which are formed on a glass (or plastic) substrate 110 by a semiconductor process, and a plurality of photosensors 116 and a sensor LSI 118 can be formed on the same substrate 110 as shown in FIG. 3.

In this case, the TFT substrate 10 of each photosensor 116 corresponds to the substrate 110, and the opposite R filter 102 and the opposite G filter 104 (as well as the black mask 106) can be formed by the same member and process as that of the TFT-LCD 112. Therefore, in terms of process steps, only the formation of the TFT R filter 100 is added. The TFT R filter 100 is formed in a region corresponding to the photosensors 116 but is not formed in a region corresponding to the TFT-LCD 112. This permits the backlight of the TFT-LCD 112 to be used as the white backlight 19 for the photosensors.

Each photosensor 116 is formed by a plurality of a-Si TFTs that are adjacently arranged vertically and horizontally in a two-dimensional form. In this case,
as shown in FIG. 4, the opposite R filters 102 and the opposite G filters 104 are formed so that they are alternately arranged vertically and horizontally. The gate electrode 12, the source and drain electrodes 18 and interconnects are formed so that the a-Si TFTs under the opposite R filters 102 are connected in parallel to each other and so that the a-Si TFTs under the opposite G filters 104 are connected in parallel to each other. That is, each a-Si TFT under an opposite R filter 102 is formed so that its gate electrode 12 is connected to one interconnect Vg, its drain electrode is connected to one interconnect Vd and its source electrode is connected to one interconnect Vs_R. In the same manner, each a-Si TFT under an opposite G filter 104 is formed so that its gate electrode 12 is connected to one interconnect Vg (in common with the gate electrodes of the a-Si TFTs under the opposite R filters 102), its drain electrode is connected to one interconnect Vd (in common with the drain electrodes of the a-Si TFTs under the opposite R filters 102) and its source electrode is connected to one interconnect Vs_G.

The interconnects Vg, Vd, Vs_R and Vs_G are connected to the sensor LSI 118. Detection circuits 120 as shown in FIG. 5 are formed in the sensor LSI 118. Here, in the sensor LSI 118, two detection circuits 120 of the same configuration are formed, one for the a-Si TFTs under the opposite R filters 102
connected in parallel and one for the a-Si TFTs under the opposite G filters 104 connected in parallel. It is to be noted that the plurality of a-Si TFTs connected in parallel to each other are equivalently indicated as one a-Si TFT in a collective manner in FIG. 5. That is, the composition of outputs of the plurality of a-Si TFTs connected in parallel is input to the detection circuit 120.

The detection circuit 120 is constituted by a current-voltage conversion circuit 122 and a comparator 124. Here, the current-voltage conversion circuit 122 includes an inverting amplifier 126 in which a predetermined voltage $V_3$ is applied to its noninverting input terminal, and a feedback resistor $R_f$ is connected between an output terminal and an inverting input terminal of the inverting amplifier 126, and the current-voltage conversion circuit 122 is formed so that the interconnect $V_{s_R}$ or $V_{s_G}$ from the a-Si TFT is connected to the inverting input terminal of the inverting amplifier 126. The comparator 124 compares a voltage value converted in the current-voltage conversion circuit 122 with a predetermined threshold voltage value $V_{t}$, and outputs an output signal $V_{out}$ indicating whether the TFT is in a receiving state or a non-receiving state.

A logic circuit 125 is further formed in the sensor LSI 118 to perform logic operations for the
output signals Vout of the two detection circuits 120. As described with reference to FIG. 2, the photosensor 116 is recognized to be on when the output signal on the side of the a-Si TFT under the opposite R filter 102 is detected to be "1" and the output signal on the side of the a-Si TFT under the opposite G filter 104 is "0". Likewise, the photosensor 116 is recognized to be off when the output signal on the side of the a-Si TFT under the opposite R filter 102 is detected to be "1" and the output signal on the side of the a-Si TFT under the opposite G filter 104 is "1" and when the output signal on the side of the a-Si TFT under the opposite R filter 102 is detected to be "0" and the output signal on the side of the a-Si TFT under the opposite G filter 104 is "0".

Thus, in one photosensor 116, a plurality of a-Si TFTs are adjacently arranged, and the a-Si TFTs under the same color filter are connected in parallel to form a composite output by which the photosensor is judged to be on or off, such that the photosensor can be accurately judged to be on or off even with a small number of detection circuits. When the output signal on the side of the a-Si TFT under the opposite R filter 102 is detected to be "0" and the output signal on the side of the a-Si TFT under the opposite G filter 104 is "1", something may be wrong with the photosensor 116. In this case, the occurrence of an error is checked and
the results of the check are preferably notified without having to determine whether the photosensor 116 is on or off.

As described above, according to the photosensor in the first embodiment of the present invention, the opposite R filters 102 and the opposite G filters 104 are disposed above the adjacent a-Si TFTs, and a mechanism is provided wherein the red component 22R of the backlight ray alone is detected by one of the a-Si TFTs to recognize the contact of the finger 24, thereby providing an advantage that erroneous operations due to the outside light 28 (mainly sunlight) can be prevented.

Furthermore, in such a photosensor, components other than the TFT R filter 100 can be constructed using the same members as those of the TFT-LCD 112, so that there is an advantage that the photosensors can be formed integrally with the TFT-LCD 112 (the TFT-LCD panel 108 with the photosensors can be manufactured without increasing the number of process steps, except to add the TFT R filter).

There is also an advantage that the backlight as part of the light emitting means of the photosensor can be used in common with the indication on the LCD.

In addition, in order for the photosensors as described above to function as the operating switches of the TFT-LCD panel 108 as the display element, a
controller (e.g., a CPU) is preferably provided to control the display element on the basis of the timing with which the photosensors switches are judged to turn from off to on or on to off.

[Second Embodiment]

FIG. 6 is a diagram showing an example of the configuration of a photosensor according to a second embodiment of the present invention. In the description of the photosensor according to the second embodiment, the same reference numbers are assigned to parts similar to those in the photosensor according to the first embodiment, and these parts are not described. Moreover, for simplicity, only two a-Si TFTs alone are shown.

In the photosensor according to the present second embodiment, a double-gate a-Si TFT is employed instead of the a-Si TFT in the first embodiment.

That is, each of the double-gate a-Si TFTs includes a gate electrode 12 formed on a transparent TFT substrate 10, a transparent insulating film 14 formed on the gate electrode 12, an a-Si part 16 formed opposite to the gate electrode 12 on the insulating film 14, source and drain electrodes 18 formed on the a-Si part 16, and a transparent top gate electrode 128 provided on the insulating film 14 and covering the tops of the a-Si part 16 and the source and drain electrodes 18 (i.e., provided at a position
corresponding to the a-Si part 16 and the source and drain electrodes 18).

According to the photosensor using such double-gate a-Si TFTs, effects similar to those in the first embodiment can be obtained, and the control timings of two gates can be staggered to control sensitivity characteristics, such that the ratio between light and dark outputs can be high.

While the present invention has been described in connection with the embodiments, the present invention is not limited to the embodiments described above, and various modifications and applications can be made without departing from the spirit of the present invention.

For example, the red and green color filters are formed under the opposite substrate 20 in the embodiments described above, but color filters of other colors may be formed. In that case, it will be appreciated that one of the colors of the color filters provided instead of the red and green color filters is the same as the color of the color filter under the TFT substrate 10 (which may be a color other than red). Moreover, the kinds of colors are not limited to two, and more colors may be used. In that case, the color filter under the TFT substrate 10 has to be divided into regions to form a plurality of colors so that a plurality of kinds of monochromatic rays can be
Radiated.

Furthermore, the color filters are disposed under the opposite substrate 20 in the embodiments described above, but they may be disposed on the top of the opposite substrate 20 or on the top of the transparent insulating film 14 covering the a-Si part 16.

Still further, the white backlight and the red color filter under the TFT substrate 10 are used as the light emitting means for emitting light of a particular wavelength region to generate the monochromatic ray of the red component 22R in the embodiments described above, but a light source such as an LED or OLED capable of irradiating a monochromatic ray may be used instead of providing such a color filter.

Still further, the a-Si TFTs are connected in parallel to provide one detection circuit 120 (FIG. 5) for each color in the embodiments described above, but one detection circuit 120 may be provided for each a-Si TFT so that the each a-Si TFT is individually judged to be on or off and with this structure the results of the judgments regarding all the a-Si TFTs constituting one photosensor 116 are totaled to make a final judgment on whether the photosensor 116 is on or off. It should further be understood that the detection circuit is not limited to the configuration shown in FIG. 5.

Still further, while the case of the double-gate type a-Si TFT has been above described in the second
embodiment, it is also possible to employ a multi-gate a-Si TFT having more gate electrodes.

Still further, not only the a-Si TFT but also other TFTs such as a polysilicon TFT may be used as the light receiving element.

Further yet, the present invention is not limited to the transistors such as the TFT, and other light receiving elements such as a photodiode may be used.
CLAIMS

1. A photosensor comprising:
   first and second light receiving elements which detect light;
   a light source which is disposed behind the first and second light receiving elements and which emits light of a predetermined color component;
   a first filter which is disposed in front of the first light receiving element and which transmits light of the predetermined color component;
   a second filter which is disposed in front of the second light receiving element and which shuts off the light of the predetermined color component and transmits a color component other than the predetermined color component; and
   judging means for judging whether or not a detection target is present in front of the first and second filters based on outputs from the first and second light receiving elements.

2. The photosensor according to claim 1, wherein the first and second light receiving elements are adjacently arranged with a predetermined space therebetween so that the light from the light source passes between the first and second light receiving elements.

3. The photosensor according to claim 1, wherein the light source includes a third filter which only
transmits the light of the predetermined color component.

4. The photosensor according to claim 1, wherein the judging means:

judges that the detection target is present in front of the first and second filters when an amount of light detected by the first light receiving element is equal to or greater than a predetermined first threshold value and an amount of light detected by the second light receiving element is below a predetermined second threshold value, and

judges that the detection target is not present in front of the first and second filters when one of: (i) the amount of light detected by the first light receiving element is equal to or greater than the first threshold value and the amount of light detected by the second light receiving element is equal to or greater than the second threshold value and (ii) when the amount of light detected by the first light receiving element is below the first threshold value and the amount of light detected by the second light receiving element is below the second threshold value.

5. A photosensor comprising:
light emitting means for emitting light of a particular wavelength region;
irradiating light selecting means for selectively transmitting the light emitted from the light emitting
means to outside the photosensor, the irradiating light selecting means comprising a first filter and a second filter which are adjacent to each other, the first filter having a transparent wavelength region identical to the particular wavelength region so as to transmit the light emitted from the light emitting means, and the second filter having a transparent wavelength region different from the particular wavelength region so as to prevent transmission of the light emitted from the light emitting means;

a light receiving element array comprising a plurality of light receiving elements adjacently arranged to correspond to the first and second filters, the plurality of light receiving elements including a first light receiving element which receives light transmitted from outside of the photosensor through the first filter of the irradiating light selecting means and a second light receiving element which receives light transmitted from outside of the photosensor through the second filter of the irradiating light selecting means; and

judging means for judging whether or not a detection target is present in accordance with an output from the light receiving element array.

6. The photosensor according to claim 5, wherein the first light receiving element of the light receiving element array alone receives light which is
emitted from the light emitting means, radiated through
the irradiating light selecting means and reflected by
the detection target, and

wherein the judging means judges that the
detection target is present when a predetermined output
is obtained from the first light receiving element of
the light receiving element array alone.

7. The photosensor according to claim 5, wherein
outside light from sources other than the light
emitting means penetrates through both the first and
second filters of the irradiating light selecting means
and is received by both the first and second light
receiving elements of the light receiving element
array, and

wherein the judging means judges that the
detection target is absent when a predetermined output
is obtained from both the first and second light
receiving elements of the light receiving element
array.

8. The photosensor according to claim 5, wherein
the judging means judges that the detection target is
absent when a predetermined output is not obtained from
either the first or second light receiving element of
the light receiving element array.

9. The photosensor according to claim 5, wherein
the light receiving element array includes a plurality
of the first light receiving elements and a plurality
of the second light receiving elements,

wherein outputs from the first light receiving elements are connected to each other and input to the judging means, and

wherein outputs from the second light receiving elements are connected to each other and input to the judging means.

10. The photosensor according to claim 5, wherein each said light receiving element comprises an amorphous silicon thin-film transistor.

11. The photosensor according to claim 5, wherein each said light receiving element comprises a double-gate amorphous silicon thin-film transistor.

12. The photosensor according to claim 5, wherein the light emitting means for emitting the light of the particular wavelength region includes:

   a white light source which emits white light; and
   a third filter which has a transparent wavelength region identical with the particular wavelength region and which transmits the light emitted from the white light source in the particular wavelength region.

13. A target detection method for a photosensor, the photosensor comprising:

   emitting light of a particular wavelength region from a light source of the photosensor;
   selectively transmitting the light from the light source to outside of the photosensor via a first filter
and a second filter of the photosensor which are adjacent to each other, the first filter having a transparent wavelength region identical to the particular wavelength region so as to transmit the light emitted from the light source, and the second filter having a transparent wavelength region different from the particular wavelength region so as to prevent transmission of the light emitted from the light source;

receiving light from outside of the photosensor at a light receiving element array, which comprises a plurality of light receiving elements that are adjacently arranged to correspond to the first and second filters, the plurality of light receiving elements including a first light receiving element which receives light transmitted from outside of the photosensor through the first filter and a second light receiving element which receives light transmitted from outside of the photosensor through the second filter;

and

judging whether or not a detection target is present in accordance with an output from the light receiving element array.

14. The method according to claim 13, wherein the first light receiving element of the light receiving element array alone receives light which is radiated from the light source and reflected by the detection
target, and

wherein the detection target is judged to be present when a predetermined output is obtained from the first light receiving element of the light receiving element array alone.

15. The method according to claim 13, wherein outside light from sources other than the light source penetrates through both the first and second filters and is received by both the first and second light receiving elements of the light receiving element array, and

wherein the detection target is judged to be absent when a predetermined output is obtained from both the first and second light receiving elements of the light receiving element array.

16. The method according to claim 13, wherein the detection target is judged to be absent when a predetermined output is not obtained from either the first or second light receiving element of the light receiving element array.

17. A display panel comprising:

light emitting means for emitting light of a particular wavelength region;

irradiating light selecting means for selectively transmitting the light emitted from the light emitting means to outside of the display panel, the irradiating light selecting means comprising a first filter and a
second filter which are adjacent to each other, the first filter having a transparent wavelength region identical to the particular wavelength region so as to transmit the light emitted from the light emitting means, and the second filter having a transparent wavelength region different from the particular wavelength region so as to prevent transmission of the light emitted from the light emitting means;

a light receiving element array comprising a plurality of light receiving elements are adjacently arranged to correspond to the first and second filters, the plurality of light receiving elements including a first light receiving element which receives light transmitted from outside of the display panel through the first filter of the irradiating light selecting means and a second light receiving element which receives light transmitted from outside of the display panel through the second filter of the irradiating light selecting means;

judging means for judging whether or not a detection target is present in accordance with an output from the light receiving element array; and

a display element.

18. The display panel according to claim 17, wherein the display element is controlled so that power to the display panel is turned on or off based on the result of the judgment by the judging means.
19. The display panel according to claim 17,
wherein the light receiving element array is formed on
a substrate of the display element.

20. The display panel according to claim 17,
wherein at least one of the first filter and the second
filter a same member as a color filter of the display-
element.

21. The display panel according to claim 17,
wherein the light emitting means comprises a backlight
of the display element.

22. A display panel comprising:
a display element which indicates information; and
an operating switch which controls a state of the
display element,
wherein the operating switch comprises:
first and second light receiving elements
which detect light;
a light source which is disposed behind the
first and second light receiving elements and which
emits light of a predetermined color component;
a first filter which is disposed in front of
the first light receiving element and which transmits
light of the predetermined color component;
a second filter which is disposed in front of
the second light receiving element and which shuts off
the light of the predetermined color component and
transmits a color component other than the
predetermined color component; and
judging means for judging whether or not a
detection target is present in front of the first and
second filters in based on outputs from the first and
second light receiving elements.

23. The display panel according to claim 22,
wherein the first and second light receiving elements
are adjacently arranged with a predetermined space
therebetween so that the light from the light source
passes between the first and second light receiving
elements.

24. The display panel according to claim 22,
wherein the light source includes a third filter which
only transmits the light of the predetermined color
component.

25. The display panel according to claim 22,
wherein the judging means:
judges that the detection target is present in
front of the first and second filters when an amount of
light detected by the first light receiving element is
equal to or greater than a predetermined first
threshold value and an amount of light detected by the
second light receiving element is below a predetermined
second threshold value, and
judges that the detection target is not present in
front of the first and second filters when one of: (1)
the amount of light detected by the first light
receiving element is equal to or greater than the first threshold value and the amount of light detected by the second light receiving element is equal to or greater than the second threshold value and (ii) when the amount of light detected by the first light receiving element is below the first threshold value and the amount of light detected by the second light receiving element is below the second threshold value.
FIG. 2

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FIG. 3

108

110

112

TFT-LCD VIEW AREA

114

LCD DRIVER LSI

116

SENSOR LSI

118

FPC
FIG. 5
FIG. 6

FIG. 7
PRIOR ART
**INTERNATIONAL SEARCH REPORT**

International application No
PCT/JP2007/070036

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01L27/146 H01L31/14 H01L31/0392

According to International Patent Classification (IPC) or to both national classification and IPC

B. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search
23 January 2008

Date of mailing of the international search report
01/02/2008

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Markmann, Markus

Form: PCT/ISA/210 (second sheet) (April 2005)
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