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(54) LIQUID CRYSTAL DISPLAY DEVICE PERFORMING BOTH IMAGE DISPLAY MODE AND FINGERPRINT RECOGNITION MODE

(76) Inventors: **Choong Hoo Kim**, Seoul (KR); **Kyu Chang Park**, Seoul (KR); **Min Soo Shim**, Seoul (KR)

Correspondence Address:
LADAS & PARRY
224 SOUTH MICHIGAN AVENUE, SUITE 1200
CHICAGO, IL 60604 (US)

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(57) **ABSTRACT**

Disclosed is a liquid crystal display device. The device comprises a scan drive unit for selectively outputting turn-on/turn-off signals in the image display mode and outputting turn-on signals in the fingerprint recognition mode; a data drive unit for outputting data signals in the image display mode; a switch control unit for outputting turn-off signals in the image display mode and for selectively outputting turn-on/turn-off signals in the fingerprint recognition mode; a reading unit for outputting fingerprint image information read in the fingerprint recognition mode; a sensor thin film transistor for driving liquid crystal in the image display mode; and a switch thin film transistor having a channel with a first end and a second end, a drain and a source.

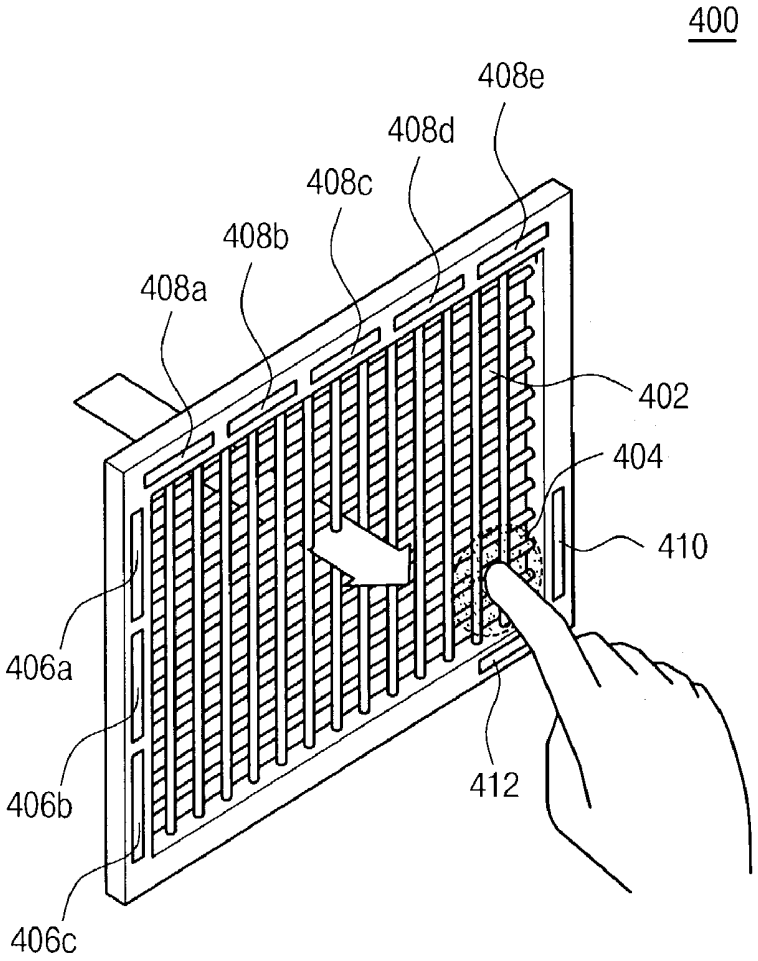


FIG. 1

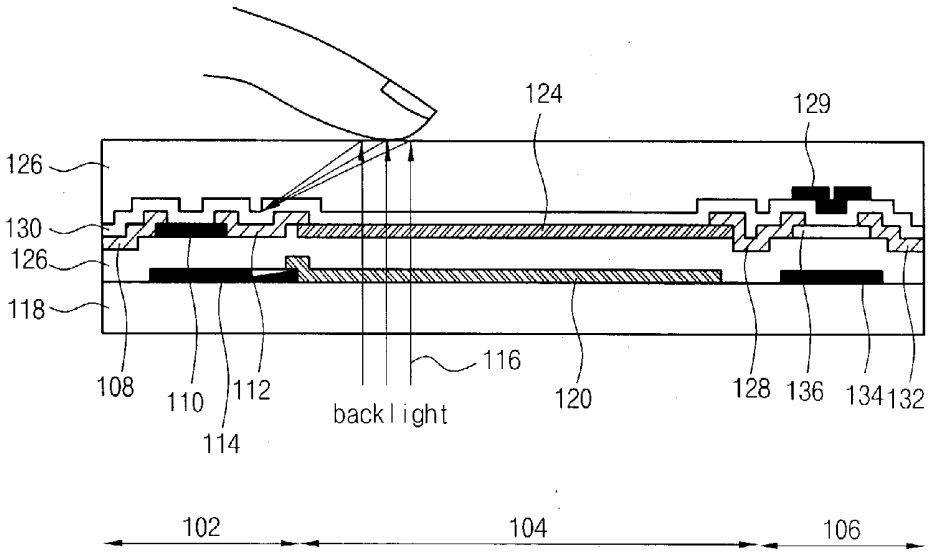

124
129
126
130
126
118
108
110
112
114
116
backlight
120
128
136
134
132
102
104
106

FIG.2

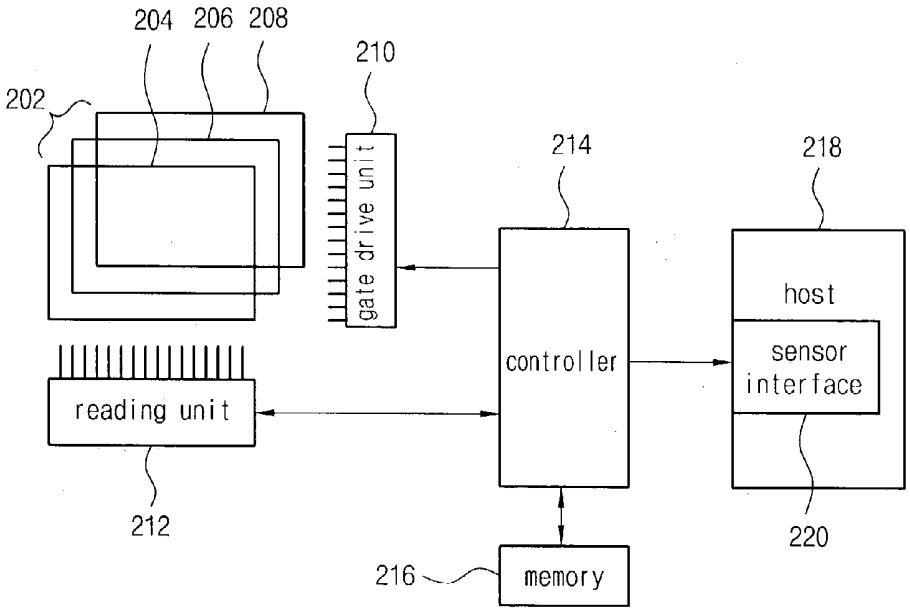

204
206
208
210
202
gate drive unit
214
218
host
controller
sensor interface
reading unit
212
220
216
memory

FIG.3

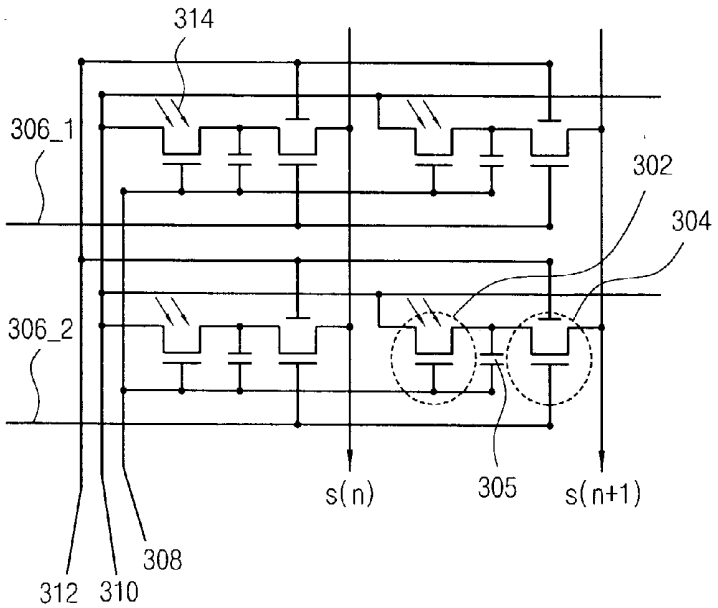

314
306_1
302
304
306_2
s(n)
305
s(n+1)
308
312
310

FIG.4

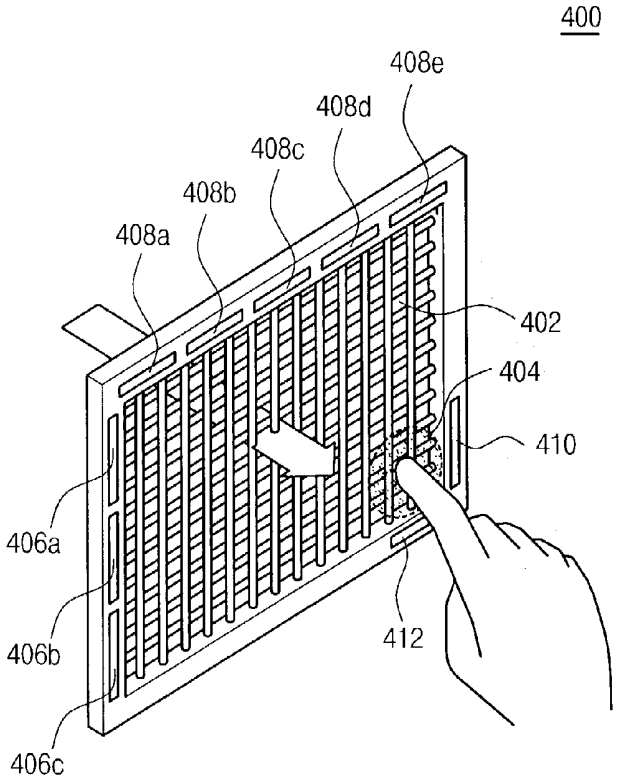

400
408e
408d
408c
408b
408a
402
404
410
406a
406b
406c
412

FIG.5

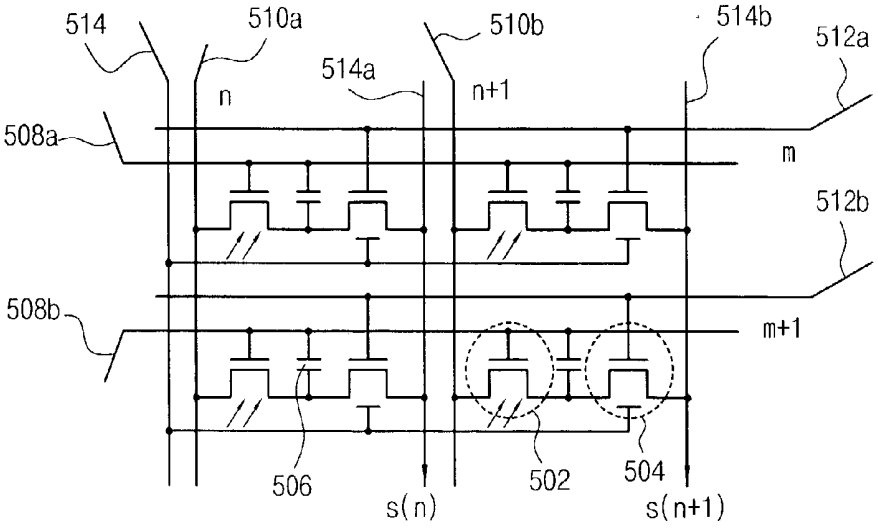
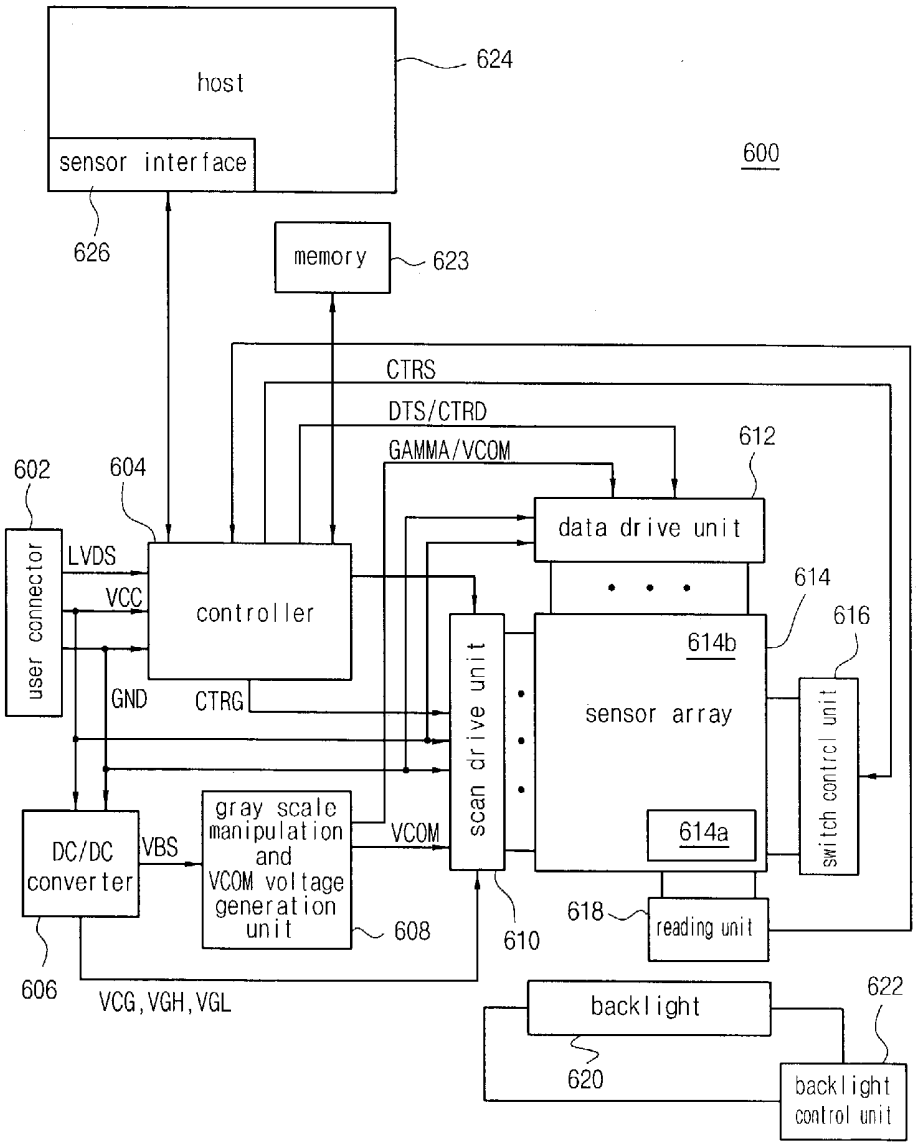

514
510a
510b
514b
512a
514a
n
n+1
508a
m
512b
508b
m+1
506
s(n)
502
504
s(n+1)

FIG.6


host
624
sensor interface
626
600
memory
623
CTRS
DTS/CTRD
GAMMA/VCOM
612
602
604
data drive unit
user connector
LVDS
VCC
controller
614
616
614b
GND
CTRG
scan drive unit
sensor array
switch control unit
614a
DC/DC converter
VBS
gray scale manipulation and VCOM voltage generation unit
VCOM
608
610
618
reading unit
606
VCG, VGH, VGL
backlight
622
620
backlight control unit

LIQUID CRYSTAL DISPLAY DEVICE PERFORMING BOTH IMAGE DISPLAY MODE AND FINGERPRINT RECOGNITION MODE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a liquid crystal display device, and more particularly to a liquid crystal display device which performs both image display mode and fingerprint recognition mode. The liquid crystal display device according to the present invention is more effective than a piezoelectric sensor or an optical sensor which uses one or more semiconductor components and is generally employed in fingerprint recognition-based security/authentication techniques, in view of reliability and costs. Furthermore, the present invention is directly applicable to STN or TFT-LCD products which themselves have a very wide applicability, so that it can be employed in an electronic commerce system, a security system, a personal recognition/authentication system or the like.

[0003] 2. Description of the Prior Art

[0004] As generally known in the art, password input mode has been principally used for electronic commerce, security, authentication and the like, up to the present. However, since the password input mode is likely to be hacked into, various modes have been developed lately for recognizing biometrical information such as fingerprints.

[0005] **FIG. 1** is a longitudinal section view of a unit cell in a conventional fingerprint recognition device which employs thin film transistors (TFTs), and **FIG. 2** shows a circuit for driving such a fingerprint recognition device. As shown in **FIG. 1, a** unit cell of the conventional fingerprint recognition device **100** comprises: a sensor TFT **102** for sensing light; a switch TFT **106** for outputting recognized fingerprint information, the sensor TFT and the switch TFT being transversely aligned; a transparent substrate **118**; and a backlight **116** for emitting light upward from the underside of the transparent substrate **118**, the light passing through an electricity charging unit or a light transmission part **104**. A sensor source electrode **112** of the sensor TFT **102** and a switch drain electrode **128** of the switch TFT **106** are electrically connected to each other through a first transparent electrode **124**. A second transparent electrode **120** is connected to a sensor gate electrode **114** of the sensor TFT **102**. In addition, a photosensitive layer **110** such as amorphous silicon (a-Si:H) is formed between the sensor drain electrode **108** and the sensor source electrode **112**, so that the sensor drain electrode **108** and the sensor source electrode **112** become electrically conductive if a predetermined amount of light is incident into the photosensitive layer **110**. If a fingerprint is in contact with a coating **126** formed on the top of the unit cell, the light generated from the backlight **116** underneath the transparent substrate **118** is reflected along the pattern of the fingerprint and received by the photosensitive layer **110** of the sensor TFT **102**, thereby rendering the TFT **102** to be electrically conductive. A dielectric insulation film **126** functions to isolate the second electrode **124**, the sensor gate electrode **114** and the switch gate electrode **136**.

[0006] Meanwhile, the switch TFT **106** is switched frame by frame, the frames being set to scan a fingerprint by a gate control signal applied to the switch gate electrode **136**. Consequently, each sensor TFT **102** scans a fingerprint image inputted into the fingerprint recognition device **100**, thereby forming a frame. The fingerprint image scanned in this manner is outputted via the switch source electrode **132**. A photosensitive layer **134** is also formed in the switch TFT **106** as in the sensor TFT during the manufacturing process of the fingerprint recognition sensor, but a light shut-off layer **129** is formed on a protective layer **130** so that the switch TFT **106** is not turned on by the light received into the photosensitive layer **134**.

[0007] Referring to **FIG. 2**, if a TFT sensor **202**, which consists of a light-emitting unit **204**, a panel **206** and a coating **208**, is turned on by a gate drive unit **210** to scan a fingerprint as described above, fingerprint image information is inputted into a reading unit **212**, sent to a control unit **214** and then compared with fingerprint data which has already been inputted into a memory **216**. The result of the comparison is sent to a sensor interface **220** of a host computer, so that a process related to security and authentication then proceeds.

[0008] **FIG. 3** is an equivalent circuit diagram for an array of conventional fingerprint recognition components. As shown in **FIG. 3, a** unit cell comprises a sensor TFT **302** and a switch TFT **304**, and the capacitance existing at the connection between the sensor TFT **302** and the switch TFT **304** is modeled by a capacitor **305**. As shown in **FIG. 3**, lines **306_1** and **306_2** are connected to the gate of the switch TFT **304**, and line **308** is connected to the gate of the sensor TFT **302**. Line **310** is a data line of the sensor TFT **302** and line **312** functions to outwardly discharge static electricity which may be generated in the light shut-off layer **129** (**FIG. 1**).

[0009] The afore-mentioned fingerprint recognition devices should be separately provided in an electronic commerce system, a security system, a control system and the like. Recently, in connection with the increase of personal portable equipment, mobile phones, personal portable terminals, notebook computers, personal computers and the like, various application techniques have been developed for connecting a fingerprint recognition device with such equipment. However, there is a problem in that the price and volume of a resulting product are increased because it is necessary to buy and mount a separate fingerprint device on a liquid crystal display panel or in a separate space.

SUMMARY OF THE INVENTION

[0010] Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the prior art, and an object of the present invention is to provide a liquid crystal display device of novel construction, in which a fingerprint recognition device is integrally formed with the liquid crystal display device, thereby minimizing the increase in the price and size of a resulting product.

[0011] In order to accomplish this object, there is provided a liquid crystal display device, which performs both image display mode and fingerprint recognition mode, wherein the liquid crystal display device comprises: a scan drive unit which selectively outputs one or more turn-on/turn-off signals to a corresponding row in the image display mode and which outputs one or more turn-on signals in the fingerprint recognition mode; a data drive unit which outputs one or more data signals in the image display mode; a switch

control unit which outputs one or more turn-off signals in the image display mode and which selectively outputs turn-on/turn-off signals to a corresponding row in the fingerprint recognition mode; a reading unit which outputs fingerprint image information read in the fingerprint recognition mode; a sensor thin film transistor which drives liquid crystal in the image display mode, the sensor thin film transistor having a channel with a first end and a second, a drain and a source and, in which the first end of the channel is connected to an output terminal of the data drive unit, a photosensitive layer is formed between the drain and the source of the sensor thin film transistor, and the drain and the source become electrically conductive when light exceeding a predetermined amount of light is incident into the photosensitive layer; and a switch thin film transistor having a channel with a first end and a second, a drain and a source, in which the first end of the channel of the switch thin film transistor is connected to the second end of the channel of the sensor thin film transistor, and the second end of the channel of the switch thin film transistor is connected to the input terminal of the reading unit.

[0012] According to this construction of the present invention, it becomes possible to form a photosensitive sensor device, which comprises a sensor thin film transistor, a switch thin film transistor and an electricity charging unit, in each pixel in the inside of an array substrate, itself comprising one or more active components, or a color filter substrate of a liquid crystal display device. As a result, because both image display and fingerprint recognition can be performed by one liquid display device, it is possible to minimize the increase in price and volume of a final product caused by buying and mounting a separate fingerprinting recognition device.

[0013] Preferably, the second end of the channel of the sensor thin film transistor and the first end of the channel of the switch thin film transistor are connected to a transparent electrode. The one sensor thin film transistor and the switch thin film transistor are formed on a transparent substrate, and the liquid crystal display device further comprises a light-emitting unit under the transparent substrate. The liquid crystal display device according to the present invention further comprises an electricity charging unit, wherein one end of the charging unit is connected to the second end of the channel of the sensor thin film transistor and the other end of the charging unit is connected to the first end of the channel of the switch thin film transistor, and electric charges generated from the sensor thin film transistor are accumulated in the electricity charging unit.

[0014] In addition, the liquid crystal display device further comprises a light shut-off layer formed on the top of the switch thin film transistor.

[0015] According to another aspect of the present invention, there is provided a liquid crystal display device, which performs both image display mode and fingerprint recognition mode, wherein the liquid crystal display device comprises: wherein the liquid crystal display device comprises: a scan drive unit which selectively outputs one or more turn-on/turn-off signals to a corresponding row in the image display mode and which outputs one or more turn-on signals in the fingerprint recognition mode; a data drive unit which outputs one or more data signals in the image display mode; a switch control unit which outputs one or more turn-off signals in the image display mode and which selectively outputs turn-on/turn-off signals to a corresponding row in the fingerprint recognition mode; a reading unit which outputs fingerprint image information read in the fingerprint recognition mode; and a flat panel which displays images in the image display mode and receives fingerprint images in the fingerprint recognition mode, wherein a part of the flat panel comprises: a sensor thin film transistor which drives liquid crystal in the image display mode, the sensor thin film transistor having a channel with a first end and a second, a drain and a source and, in which the first end of the channel is connected to an output terminal of the data drive unit, a photosensitive layer is formed between the drain and the source of the sensor thin film transistor, and the drain and the source become electrically conductive when light exceeding a predetermined amount of light is incident into the photosensitive layer; and a switch thin film transistor having a channel with a first end and a second, a drain and a source, in which the first end of the channel of the switch thin film transistor is connected to the second end of the channel of the sensor thin film transistor, and the second end of the channel of the switch thin film transistor is connected to the input terminal of the reading unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above and other objects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0017] **FIG. 1** shows a construction of a unit cell of a conventional fingerprint recognition component;

[0018] **FIG. 2** is a block diagram of a drive unit of the conventional fingerprint recognition component;

[0019] **FIG. 3** is a circuit diagram an array of the conventional fingerprint recognition components;

[0020] **FIG. 4** shows a construction of a liquid crystal display device in accordance with an embodiment of the present invention;

[0021] **FIG. 5** is a circuit diagram of an array of fingerprint recognition components provided in the liquid crystal display device of **FIG. 4**; and

[0022] **FIG. 6** is a block diagram of a liquid display device and a drive unit in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Hereinafter, a preferred embodiment of the present invention will be described with reference to the accompanying drawings. In the following description and drawings, the same reference numerals are used to designate the same or similar components, and so repetition of the description for the same or similar components will be omitted.

[0024] Referring to **FIG. 4, a** display panel of a liquid crystal display device **400** may comprise an image display region **402** for performing image display only and an image display/finger print recognition region **404** for performing both image display and fingerprint recognition. It is also possible to construct the entire display panel to perform both the image display and the fingerprint recognition. The image

display region **402** is same as a conventional TFT-LCD and thus is not specifically described herein. The image display/fingerprint recognition region **404** will be described later in reference to **FIG. 5**. A scan drive unit, of which the components **406***a*, **406***b*, **406***c* are shown in **FIG. 4**, selectively outputs turn-on/turn-off signals to a corresponding row in the image display mode, and outputs a turn-off signal in the fingerprint recognition mode. A data drive unit, of which the components **408***a*, **408***b*, **408***c*, **408***d*, **408***e* are shown in **FIG. 4**, output data signals to the image display region **402** and the image display/finger print recognition region **404** of the display panel in the image display mode. In the fingerprint recognition mode, a switch control unit **410** selectively outputs turn-on/turn-off signals to a corresponding row in the image display/fingerprint recognition region **404** in the fingerprint recognition mode. A reading unit **412** outputs image information read from the image display/finger print recognition region **404** in the fingerprint recognition mode.

[**0025**] **FIG. 5** is a circuit of an array of fingerprint recognition components which constitute the image display/fingerprint recognition region **404** in the liquid crystal display device shown in **FIG. 4**. As shown in **FIG. 5, a** unit cell comprises a sensor TFT **502**, a capacitor **506**, and a switch TFT **504**. The sensor TFT **502** is controlled by the scan drive unit **406** and the data drive unit **408**, so that it serves to drive liquid crystal in the image display mode and to generate photocurrent by receiving light reflected from a fingerprint in the fingerprint recognition mode. The capacitor **506** stores the photocurrent generated by the sensor TFT **502** in the form of electric charges. The switch TFT **504** is controlled by the switch control unit **410** and selectively outputs the electric charges stored in the capacitor **506** to the reading unit **412**.

[**0026**] As shown in **FIG. 5, a** gate of the sensor TFT **502** is connected to the scan drive unit **406** (**FIG. 4**) via lines **508***a*, **508***b*. A first end of a channel of the sensor TFT is connected to the data drive unit **408** (**FIG. 4**) via lines **510***a*, **510***b* and the second end of the channel of the sensor TFT is connected to a first end of a channel of the switch TFT **504**. The gate of the switch TFT **504** is connected to the switch control unit **410** (**FIG. 4**) and the second end of the channel of the switch TFT **504** is connected to the reading unit **412** (**FIG. 4**) via lines **514***a*, **514***b*. In **FIG. 5, a** light shut-off line **514** functions to discharge electric charges so that electric charges are not accumulated in the light shut-off layer (e.g. the light shut-off layer **129** shown in **FIG. 1**) formed on the switch TFT **504**.

[**0027**] The operation of this embodiment now will be described with reference to **FIGS. 4 and 5**. At first, the scan drive unit **406** (i.e., components **406***a*, **406***b*, **406***c*) applies gate signals to the gates of the TFTs to turn on sensor TFTs of a specific row and to turn off sensor TFTs of another row. The data drive unit **406** (i.e., components **408***a*, **408***b*, **408***c*, **408***d*, **408***e*) applies data signals for an image to be displayed to a first end of each channel of the sensor TFTs corresponding to the turned-on row. After data signals are applied to all of the sensor TFTs corresponding to the turned-on row, the sensor TFTs of the next row are turned-on by the scan drive unit **406** and data signals are applied to the sensor TFTs by the data drive unit **408**. In this manner, all of the rows are scanned and image data signals are applied to the liquid crystal panel. Herein, the characteristics of gate/data signals inputted to the sensor TFTs are applied in the same manner as in a conventional driving method of liquid crystal display devices without any change. In the image display mode, the switch control unit **410** applies gate signals to turn off all of the switch TFTs **504**, so that the data signals applied to the sensor TFTs via the data drive unit **408** are not outputted to the reading unit **412**. Instead, these data signals drive the liquid crystal (not shown) of the liquid crystal panel, so that an image corresponding to the applied data signals is displayed.

[**0028**] In the fingerprint recognition mode, the scan drive unit **406** applies gate signals to the gates of all of the sensor TFTs to turn off the sensor TFTs, so that the sensor TFTs cannot receive the data signals from the data drive unit **408**. As described with reference to **FIG. 1**, if the light emitted from the backlight **116** is reflected by a fingerprint and arrives at the photosensitive layer **110**, the sensor TFTs generate photocurrents depending on the amount of light that reaches the photosensitive layer **116** and the photocurrents are stored in the capacitor **506** in the form of electric charges. If the switch TFTs of a specific row are turned on by the switch control unit **410**, the electric charges stored in the capacitor **506** are outputted to the reading unit **412** through the channels of the corresponding TFTs. Thereafter, the switch TFTs of the next row are turned on by the switch control unit **410** and the electric charges stored in the capacitor **506** are outputted to the reading unit **412** through the corresponding switch TFTs. Through this procedure, it is possible to obtain image information related to the whole fingerprint.

[**0029**] **FIG. 6** is a block diagram of a fingerprint recognition device in accordance with an embodiment of the present invention. As shown in **FIG. 6**, the whole fingerprint recognition device **600** comprises: a TFT sensor array **614**, a part of which is formed with a fingerprint recognition region **614***a*, a scan drive unit **610**, a data drive unit **612**, a switch control unit **616**, a reading unit **618**, a user connector **602**, a controller **604**, a DC/DC converter **606**, a gray scale manipulation and VCOM voltage generation unit **608**, a backlight **620**, a backlight control unit **622**, and a host provided with a sensor interface **626**.

[**0030**] If the user connector **602** is connected to a power source, an image signal LVDS and source signals VCC, GND are applied to the fingerprint recognition device **600**. Using the signals LVDS, VCC and GND, the controller **604** generates and applies a gate control signal CTRG for controlling a gate of a TFT, which forms the sensor array **614**, to the scan drive unit **610**, and the controller **604** generates and applies a source data signal DTS and a data drive unit control signal CTRD to the switch control unit **612**. The power source signals VCC, GND are also provided to the DC/DC converter **606**, the scan drive unit **610**, and the data drive unit **612**. Using the provided power source signals VDD, GND, the DC/DC converter **606** generates and supplies a power source signal VBS to the gray scale manipulation and VCOM voltage generating unit **608**, and the DC/DC converter **606** generates and supplies power source signals VCG, VGH, VGL to the scan drive unit **610**. Using the power source signal VBS, the gray scale manipulation and VCOM voltage generating unit **608** generates signals VCOM, GAMMA and supplies the signal VCOM to the scan drive unit **610** and the signals GAMMA, VCOM to the data drive unit **612**.

[0031] The scan drive unit **610**, the data drive unit **612** and the switch control unit **618** are operated as described above. That is, the scan drive unit **610** renders the rows of the TFT sensor array **614** to be sequentially activated in the image display mode, and renders the TFTs of the all of the rows to be turned off in the fingerprint recognition mode. In addition, the data drive unit **612** applies data signals to the channels of the TFTs which form the sensor array **614** in the image display mode. The switch control unit **616** sequentially activates the rows in the fingerprint recognition region **616** in the fingerprint recognition mode, so that fingerprint image signals formed in the fingerprint recognition region **614***a* are outputted to the reading unit **618** frame by frame. The fingerprint image signals outputted in this manner are supplied to the controller **604**, and the controller **604** establishes a person's identity. The person's identity established in this manner is supplied to the host **624** via the sensor interface **626**, and the host **624** displays the identity in a form to be distinguishable by the user.

[0032] In the case of displaying ordinary screen information, i.e., in the image display mode, the controller **604** supplies one or more gate on/off signals for each frame to the TFT sensors positioned in the image display/fingerprint recognition region **614***a*, sequentially for each row, like the LCD-TFTs in the image display region **614***b*, through the data drive unit **612**. At this time, the controller **604** supplies one or more gate off signals to the switch TFTs positioned in the image display/fingerprint recognition region **614***a*, so that the sensor TFTs prevent the inputted data signals from being sent out to the reading unit **618**.

[0033] When the fingerprint recognition is performed, the controller **604** supplies gate off signals to all of the sensor TFTs in the image display/fingerprint recognition region **614***a* through the scan drive unit **610**. Therefore, no data signal is inputted from the data drive unit **612**. Instead, the photosensitive layer on the sensor TFTs is operated by the reflected light and generates photocurrents depending on the amount of light received in the photosensitive layer. The photocurrents having been generated in such a way are then stored in the capacitors between the sensor TFTs and the switch TFTs in the form of electric charges. The controller **604** supplies one or more gate on/off signals for each frame to the sensor TFTs positioned in the image display/fingerprint recognition region **614***a*, sequentially for each row, through the switch control unit **616**, so that the electric charges stored in the capacitor are outputted to the reading unit **618**. As a result, the entire display screen turns to black or white in accordance with the liquid crystal driving modes or displays a color in compliance with the color of the fingerprint recognition screen. While the fingerprint recognition mode is being operated, ordinary image information is not displayed. That is, the liquid crystal display device in accordance with the present invention includes two display screens, one for the image display mode and the other for the fingerprint recognition mode, and the controller supplies control signals corresponding to the image display mode and the fingerprint recognition mode so that the screens are respectively converted into displaying modes as needed.

[0034] The finger print recognition device **600** as shown in **FIG. 6** can be formed concurrently with manufacturing active components in the liquid crystal display device.

[0035] According to the present invention as described above, it becomes possible to form a photosensitive sensor component, which comprises a sensor thin film transistor, a switch thin film transistor and an electricity charging unit, within each pixel in the inside of an array substrate, which comprises active components, or a color filter substrate of a liquid crystal display device. Therefore, both image display and fingerprint recognition can be performed by one liquid display device, and thus it is possible to minimize the increase in price and volume of a final product caused by buying and mounting a separate fingerprinting recognition device.

[0036] The effects achieved by the present invention are summarized as follows:

[0037] i) Because a photosensitive sensor of a thin film transistor type, which reads and converts optical type image information into an electric signal, may be formed concurrently with producing a TFT array substrate in a liquid crystal panel to be included in the TFT array substrate, it is possible to construct a fingerprint recognition system in a mobile phone, a notebook computer, a personal portable terminal, a monitor, a television or the like;

[0038] ii) Because a photosensitive sensor and a TFT array substrate which have been produced in different production lines and by separate manufacturing processes may be concurrently produced in the same production line and by the same manufacturing process, it is possible to reduce the manufacturing time and costs;

[0039] iii) Because it is possible to reduce the occurrence of additional costs in designing and providing a fingerprint recognition device in the associated products, it is advantageous in view of the price of product; and

[0040] iv) The present invention is widely applicable, so that its utility value can be enhanced in the sphere of everyday life (e.g., an approval system for electronic commerce using an Internet) as well as in the security field. Furthermore, because it becomes easy to manufacture associated products, demand for a TFT-LCD can be increased.

[0041] The above embodiments have been specifically described in connection with fingerprint recognition. However, the present invention can be embodied as an image sensor for other purposes. The preferred embodiment of the present invention has been described for illustrative purposes, and those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. A liquid crystal display device, which performs both image display mode and fingerprint recognition mode, wherein the liquid crystal display device comprises:

a scan drive unit which selectively outputs one or more turn-on/turn-off signals to a corresponding row in the image display mode and which outputs one or more turn-on signals in the fingerprint recognition mode;

a data drive unit which outputs one or more data signals in the image display mode;

a switch control unit which outputs one or more turn-off signals in the image display mode and which selectively outputs turn-on/turn-off signals to a corresponding row in the fingerprint recognition mode;

a reading unit which outputs fingerprint image information read in the fingerprint recognition mode;

a sensor thin film transistor which drives liquid crystal in the image display mode, the sensor thin film transistor having a channel with a first end and a second, a drain and a source and, in which the first end of the channel is connected to an output terminal of the data drive unit, a photosensitive layer is formed between the drain and the source of the sensor thin film transistor, and the drain and the source become electrically conductive when light exceeding a predetermined amount of light is incident into the photosensitive layer; and

a switch thin film transistor having a channel with a first end and a second, a drain and a source, in which the first end of the channel of the switch thin film transistor is connected to the second end of the channel of the sensor thin film transistor, and the second end of the channel of the switch thin film transistor is connected to the input terminal of the reading unit.

2. The liquid crystal display device according to claim 1, wherein the switch thin film transistor is switched on for each frame in order to scan a fingerprint image.

3. The liquid crystal display device according to claim 1, wherein the second end of the channel of the sensor thin film transistor and the first end of the channel of the switch thin film transistor are connected to a transparent electrode.

4. The liquid crystal display device according to claim 1, wherein the sensor thin film transistor and the switch thin film transistor are formed on a transparent substrate, and the liquid crystal display device further comprises a light-emitting unit under the transparent substrate.

5. The liquid crystal display device according to claim 1, wherein the liquid crystal display device further comprises an electricity charging unit, one end of the charging unit being connected to the second end of the channel of the sensor thin film transistor and the other end of the charging unit being connected to the first end of the channel of the switch thin film transistor, and wherein electric charges generated from the sensor thin film transistors are accumulated in the electricity charging unit.

6. The liquid crystal display device according to claim 1, further comprising a light shut-off layer formed on the top of the switch thin film transistor.

7. A liquid crystal display device, which performs both image display mode and fingerprint recognition mode, wherein the liquid crystal display device comprises: wherein the liquid crystal display device comprises:

a scan drive unit which selectively outputs one or more turn-on/turn-off signals to a corresponding row in the image display mode and which outputs one or more turn-on signals in the fingerprint recognition mode;

a data drive unit which outputs one or more data signals in the image display mode;

a switch control unit which outputs one or more turn-off signals in the image display mode and which selectively outputs turn-on/turn-off signals to a corresponding row in the fingerprint recognition mode;

a reading unit which outputs fingerprint image information read in the fingerprint recognition mode; and

a flat panel which displays images in the image display mode and receives fingerprint images in the fingerprint recognition mode,

wherein a part of the flat panel comprises:

a sensor thin film transistor which drives liquid crystal in the image display mode, the sensor thin film transistor having a channel with a first end and a second, a drain and a source and, in which the first end of the channel is connected to an output terminal of the data drive unit, a photosensitive layer is formed between the drain and the source of the sensor thin film transistor, and the drain and the source become electrically conductive when light exceeding a predetermined amount of light is incident into the photosensitive layer; and

a switch thin film transistor having a channel with a first end and a second, a drain and a source, in which the first end of the channel of the switch thin film transistor is connected to the second end of the channel of the sensor thin film transistor, and the second end of the channel of the switch thin film transistor is connected to the input terminal of the reading unit.

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专利名称(译)	液晶显示装置执行图像显示模式和指纹识别模式		
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[标]申请(专利权)人(译)	KIM CHOONG HOO PARK KYU常 垫片民秀		
申请(专利权)人(译)	KIM CHOONG HOO PARK KYU常 垫片民秀		
当前申请(专利权)人(译)	KIM CHOONG HOO PARK KYU常 垫片民秀		
[标]发明人	KIM CHOONG HOO PARK KYU CHANG SHIM MIN SOO		
发明人	KIM, CHOONG HOO PARK, KYU CHANG SHIM, MIN SOO		
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摘要(译)

公开了一种液晶显示装置。该装置包括扫描驱动单元，用于在图像显示模式下选择性地输出开启/关闭信号，并在指纹识别模式下输出开启信号;数据驱动单元，用于在图像显示模式下输出数据信号;开关控制单元，用于在图像显示模式下输出关断信号，并在指纹识别模式下选择性地输出开启/关闭信号;读取单元，用于输出在指纹识别模式下读取的指纹图像信息;传感器薄膜晶体管，用于在图像显示模式下驱动液晶;开关薄膜晶体管，具有带第一端和第二端的沟道，漏极和源极。