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Wang et al.

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(54) **TOUCH LIQUID CRYSTAL DISPLAY DEVICE**

3/0412; G06F 3/0418; G06F 3/044; G06F 2203/04103; G06F 2203/04111

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See application file for complete search history.

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(57) **ABSTRACT**

A touch liquid crystal display device includes a first substrate and a second substrate opposite to each other, and a liquid crystal layer disposed between the first and second substrates. The first substrate includes a touch layer disposed on a surface of the first substrate facing the liquid crystal layer, an insulating layer disposed on a surface of the touch layer and covering the touch layer, and a pixel array structure disposed on a surface of the insulating layer facing away from the touch layer. The touch layer is disposed between the pixel array structure and the first substrate. Only a filming process and a photoetching process of the touch layer and a deposition process of the insulating layer are additionally required to transform a non-touch liquid crystal display device to a touch liquid crystal display device.

19 Claims, 8 Drawing Sheets

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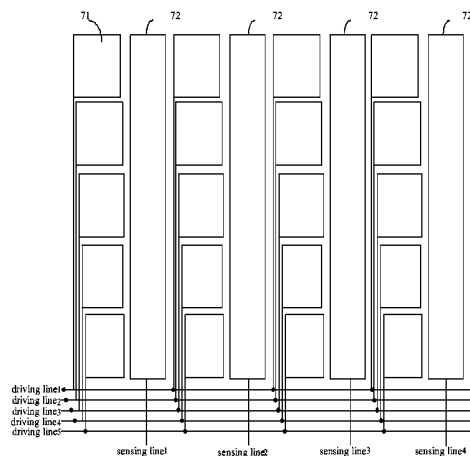
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CPC G02F 1/13338; G02F 1/134336; G06F



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(52)	U.S. Cl. CPC G06F 3/0412 (2013.01); G06F 3/0418 (2013.01); G06F 2203/04103 (2013.01); G06F 2203/04111 (2013.01)	

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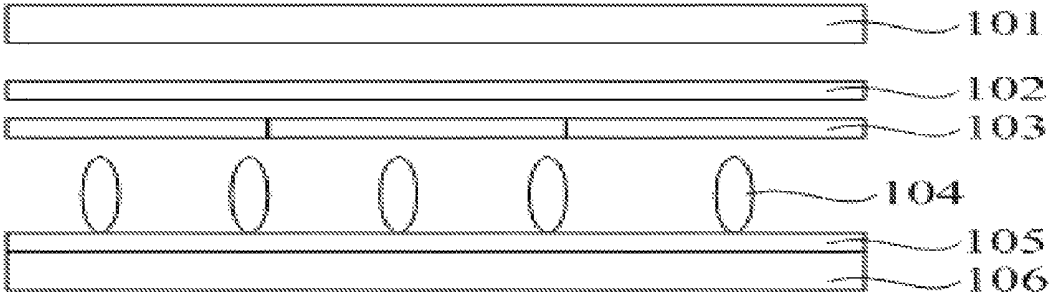


Fig. 1
(Prior Art)

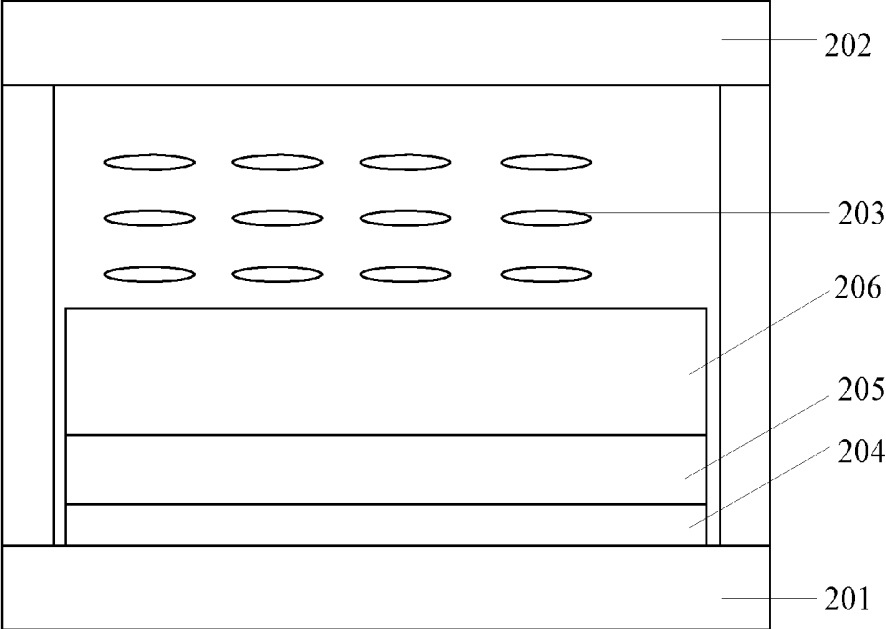


Fig. 2

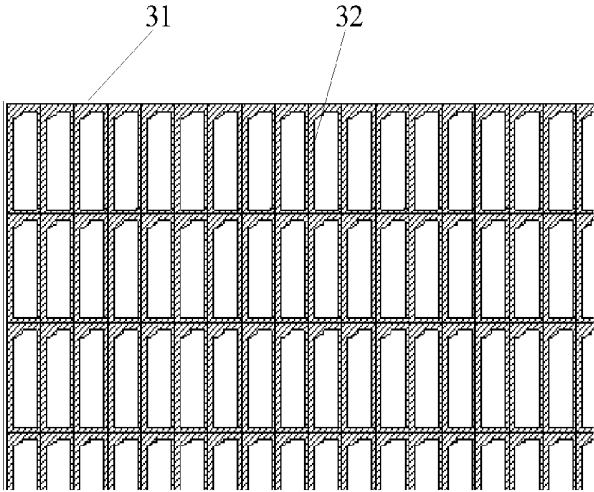


Fig. 3

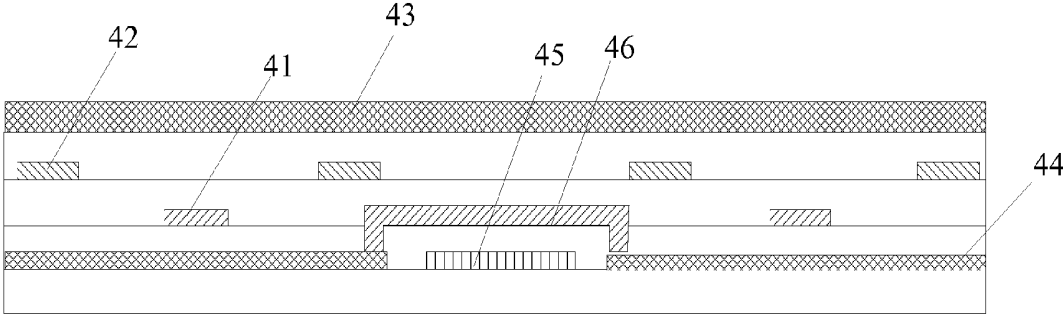


Fig. 4A

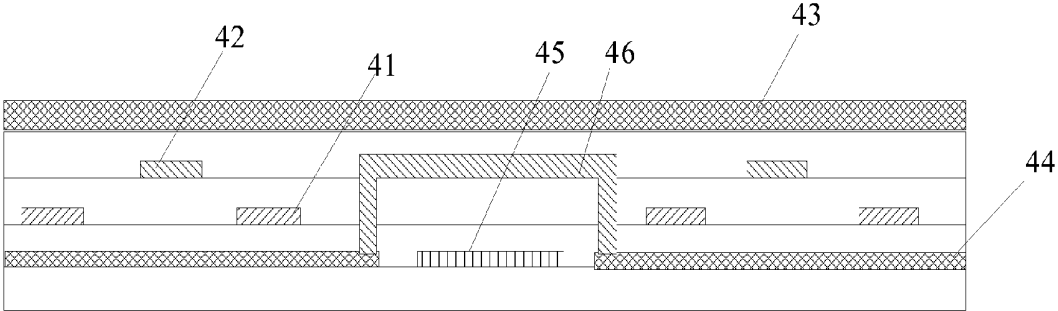


Fig. 4B

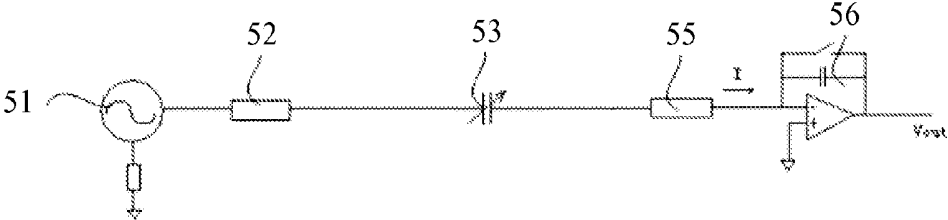


Fig. 5

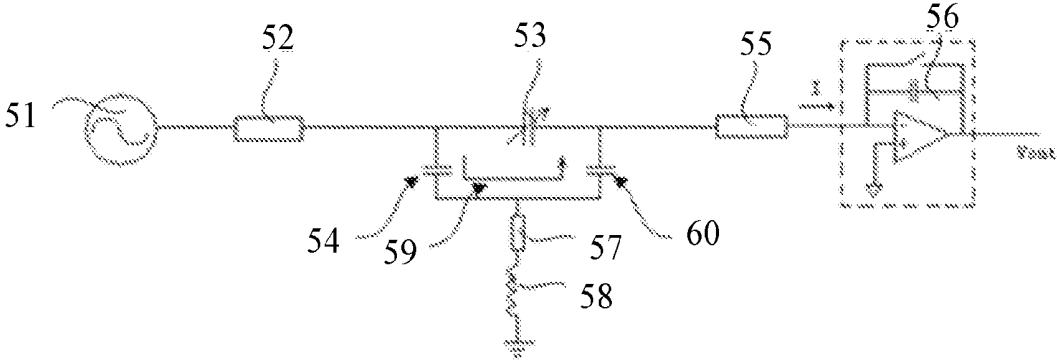


Fig. 6

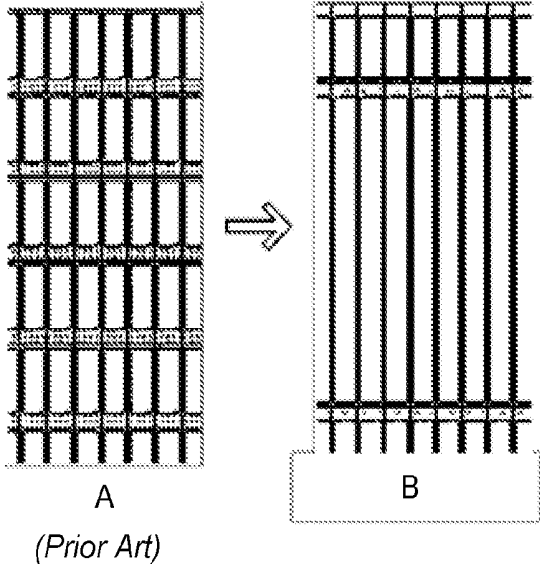


Fig. 7

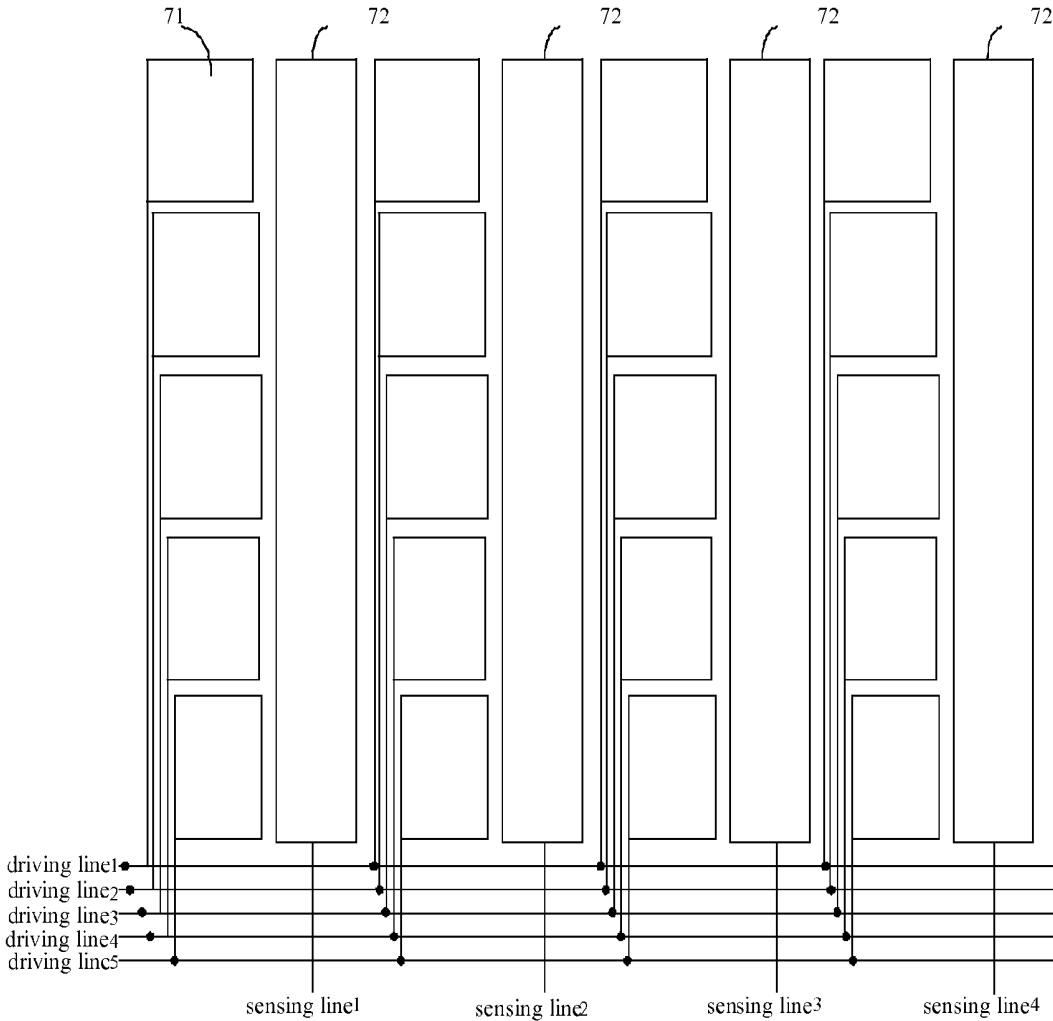


Fig. 8

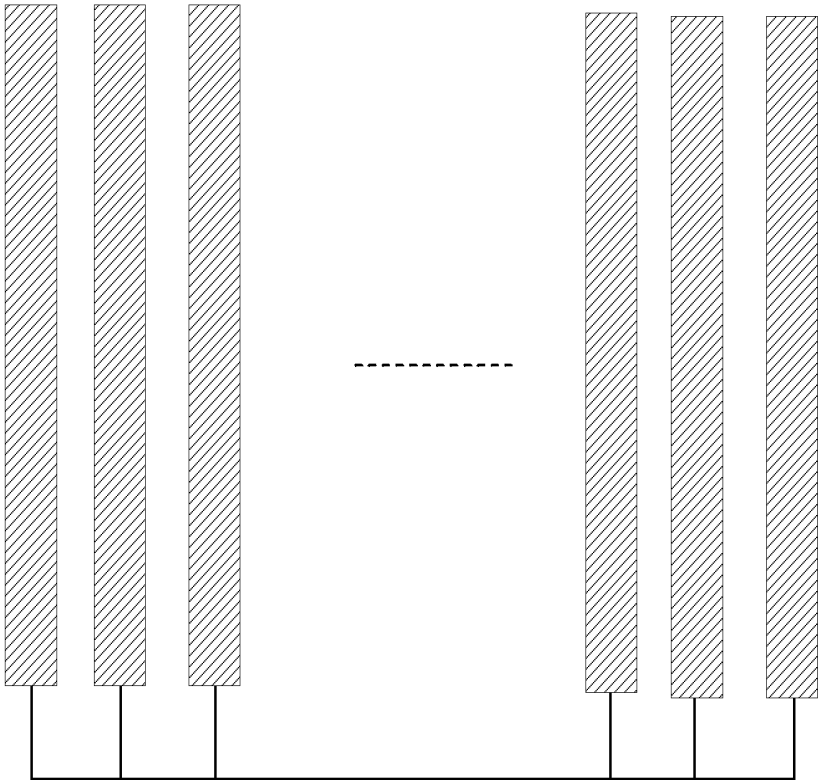


Fig. 9

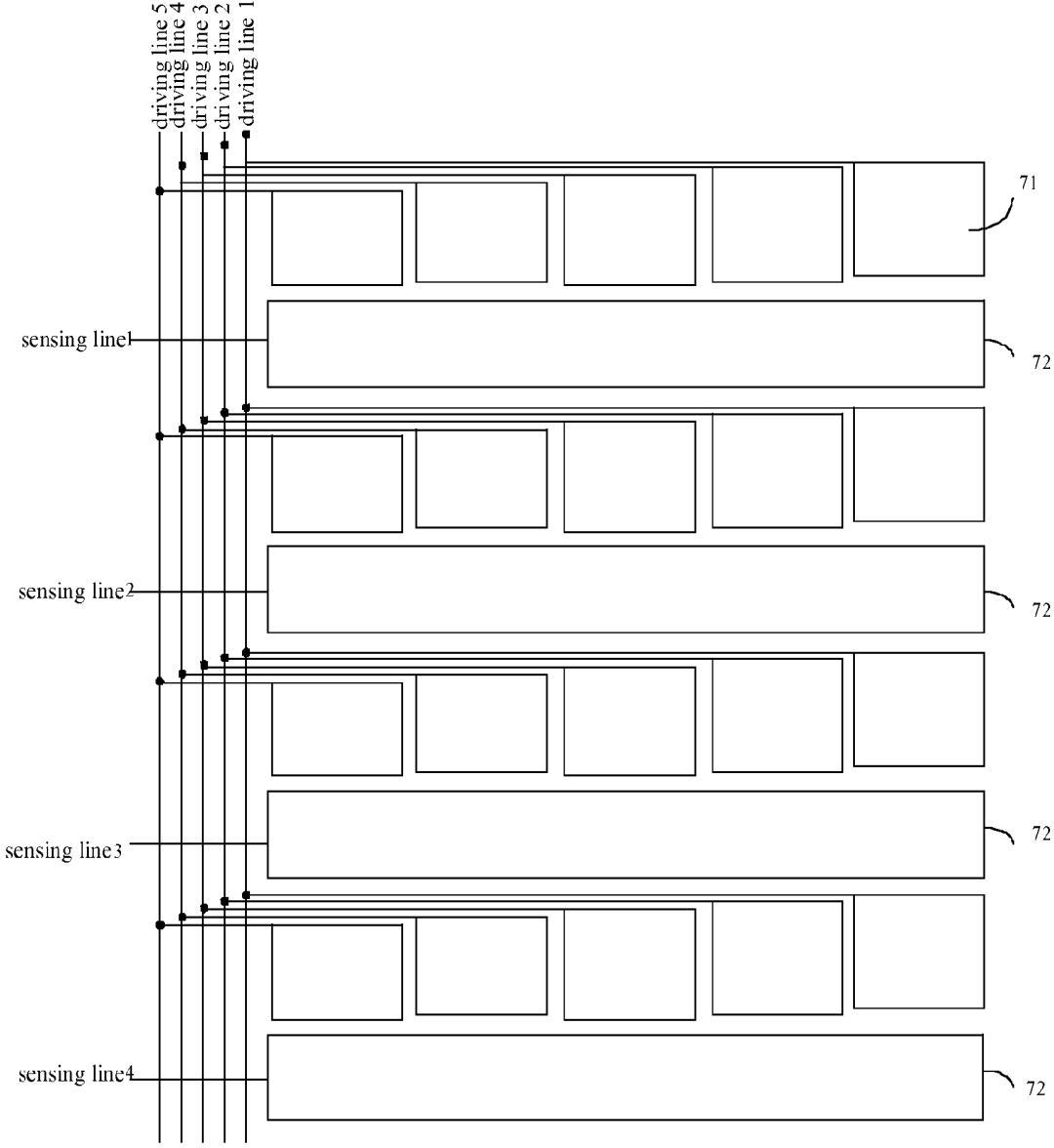


Fig. 10

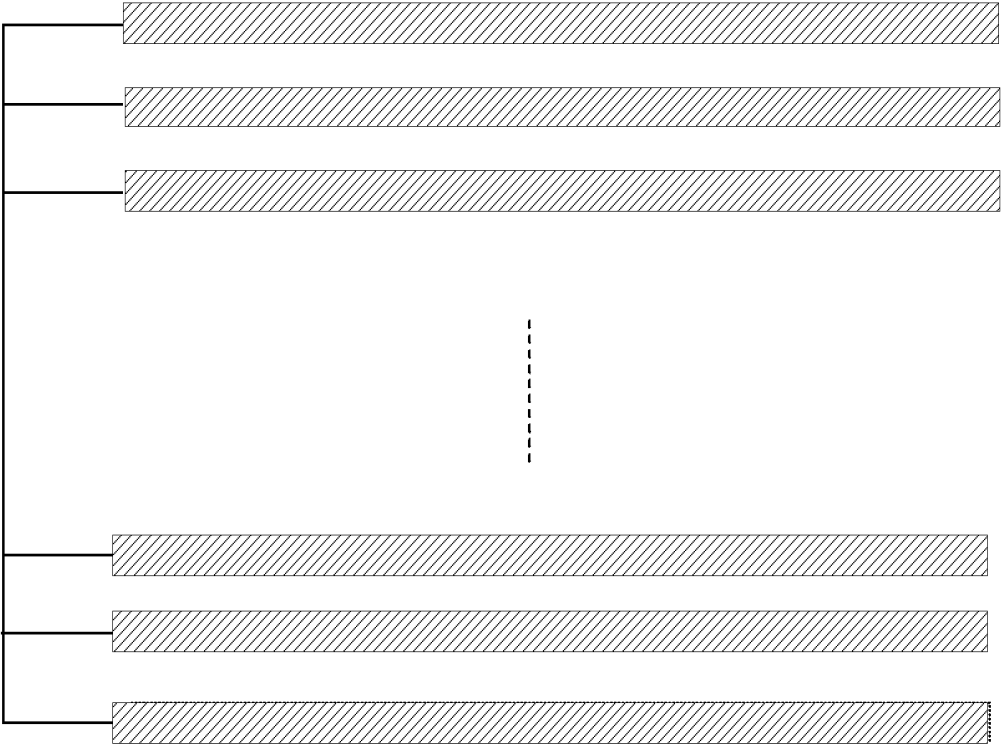


Fig. 11

TOUCH LIQUID CRYSTAL DISPLAY DEVICE

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims priority to and is a continuation of PCT/CN2013/074005, filed on Apr. 10, 2013, which claims the benefit of Chinese patent application No. 201210359790.3, entitled "TOUCH LIQUID CRYSTAL DISPLAY DEVICE", filed with the State Intellectual Property Office on Sep. 24, 2012, the contents of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

The present invention relates to touch display, and in particular to a touch liquid crystal display device.

BACKGROUND OF THE INVENTION

Touch panels, as input mediums, can provide simple, convenient and natural human-computer interactions at present. Therefore, touch panels are used more and more in many electronic products such as mobile phones, laptops, MP3/MP4 players and the like. In order to reduce the cost of an electronic device and make the electronic device lighter and thinner, a touch panel is generally integrated into the liquid crystal display panel.

In order to make the liquid crystal display with touch function lighter and thinner, an in-cell touch display is developed in the prior art, in which the touch panel is integrated with the liquid crystal display panel. However, the process for manufacturing the in-cell touch liquid crystal display apparatus in the prior art is complex.

BRIEF SUMMARY OF THE INVENTION

Certain embodiments of the present invention relate to a touch liquid crystal display device. In some embodiments, the touch liquid crystal display device includes a first substrate and a second substrate, the first substrate and the second substrate are opposite to each other, and a liquid crystal layer disposed between the first substrate and the second substrate. The first substrate comprises a touch layer disposed on a surface of the first substrate facing the liquid crystal layer, an insulating layer disposed on a surface of the touch layer and covering the touch layer, and a pixel array structure disposed on a surface of the insulating layer facing away from the touch layer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified structural diagram of an in-cell touch display in the prior art;

FIG. 2 is a simplified structural diagram of a touch liquid crystal display device according to an embodiment of the present invention;

FIG. 3 is a simplified structural diagram of part of driving electrodes or part of sensing electrodes in a touch layer in the touch liquid crystal display device according to an embodiment of the present invention;

FIG. 4A is a simplified structural diagram of a first substrate in a touch liquid crystal display device according to an embodiment of the present invention; FIG. 4B is a simplified structural diagram of the first substrate in the touch liquid crystal display device according to another embodiment of the present invention;

FIG. 5 is a schematic diagram of an ideal equivalent circuit of the touch liquid crystal display device according to an embodiment of the present invention;

FIG. 6 is a schematic diagram of an actual equivalent circuit of the touch liquid crystal display device according to an embodiment of the present invention;

FIG. 7 are simplified diagrams for comparing the structure of the driving electrodes or the sensing electrodes in the prior art and the structure of the driving electrodes or the sensing electrodes according to another embodiment of the present invention, where FIG. 7A illustrates a structural schematic diagram of the driving electrodes or the sensing electrodes in the prior art, and FIG. 7B illustrates a structural schematic diagram of the driving electrodes or the sensing electrodes according to another embodiment of the present invention;

FIG. 8 is a simplified structural diagram of a touch layer in a touch liquid crystal display device according to another embodiment of the present invention;

FIG. 9 is a simplified structural diagram of a common electrode layer in the touch liquid crystal display device according to another embodiment of the present invention;

FIG. 10 is a simplified structural diagram of a touch layer in a touch liquid crystal display device according to another embodiment of the present invention; and

FIG. 11 is a simplified structural diagram of a common electrode layer in the touch liquid crystal display device according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a simplified structural diagram of an in-cell touch display in the prior art. The in-cell liquid crystal display includes: an upper substrate **101**, a touch panel **102** located under the upper substrate **101**, a color filter layer **103** located under the touch panel **102**, a liquid crystal layer **104** located under the color filter layer **103**, a pixel array structure **105** located under the liquid crystal layer **104** and a lower substrate **106** located under the pixel array structure **105**.

As shown in FIG. 1, in the in-cell touch display in the prior art, the touch panel **102** is disposed between the color filter layer **103** and the upper substrate **101**. In the prior art, the color filter layer **103** and the liquid crystal display panel are usually manufactured by different manufacturers. A manufacturer of color filter layer **103** mainly performs certain pre-production processes, which may include providing a substrate; forming a color filter layer on a surface of the substrate; planarizing the color filter layer to form a color filter structure. A manufacturer of the liquid crystal display panel performs post production based on the pre-produced color filter structure obtained directly from the manufacture of the color filter, so as to obtain a liquid crystal display device.

Therefore, the pre-production process of the color filter structure needs to be changed to embed the touch panel **102** between the color filter layer **103** and the upper substrate **101** for manufacturing the in-cell liquid crystal display, and the changed preliminary production process of the color filter structure may include: providing a substrate; forming a touch panel on a surface of the substrate; forming a color filter layer on a surface of the touch panel; and planarizing the color filter layer. A touch panel may be formed on a surface of the substrate by forming an electrode layer on the surface of the substrate, and etching the electrode layer to form the touch panel on the surface of the substrate.

However, in the prior art, manufactured devices used by manufacturers of the color filter structure are too coarse to accomplish fine process such as etching. Moreover, different

in-cell liquid crystal displays have different requirements on the touch panels, and the manufacturers of the color filter structure are not able to provide a color filter structure suitable for all in cell liquid crystal displays, which are not conducive to batch production. Therefore, the manufacturers of the liquid crystal display panel have to change the pre-produced color filter structure obtained from the manufacturers of the color filter structure prior to integrating with the touch panel, and the process is complex.

In addition, not only a driving circuit for providing a driving signal to the pixel array structure but also a driving circuit for providing a driving signal to the electrode in the touch panel need to be configured in the structure of the in-cell touch display. Two implementations are as follows. Each of the pixel array structure and the electrode in the touch panel may be provided with a driving circuit. Alternatively, the pixel array structure is provided with a driving circuit, and a signal transmission circuit is provided for transmitting a driving signal from the driving circuit to the electrode in the touch panel. However, both the above implementations will increase the size of the in cell touch display device.

In addition, in the case where the in cell touch display includes multiple driving electrodes and multiple sensing electrodes, and the multiple driving electrodes and multiple sensing electrodes are interleaved with each other and insulated from each other, the driving electrodes includes multiple driving sub-electrodes insulated from each other, or the sensing electrodes includes multiple sensing sub-electrodes insulated from each other. Therefore, a bridge structure needs to be disposed in the touch layer of the in cell touch display for electrically connecting the adjacent driving sub-electrodes or the adjacent sensing sub-electrodes, so the complexity of the process for manufacturing the in cell touch display and the thickness of the in cell liquid crystal display are increased.

In view of the above, embodiments of the present invention provide a touch liquid crystal display device. As illustrated in FIG. 2, the touch liquid crystal display device includes a first substrate **201** and a second substrate **202** which are opposite to each other, and a liquid crystal layer **203** disposed between the first substrate **201** and the second substrate **202**. In addition, the touch liquid crystal display device further includes a touch layer **204** disposed on a surface of the first substrate **201** facing the liquid crystal layer **203**, an insulating layer **205** disposed on a surface of the touch layer **204** and covering the touch layer **204**, and a pixel array structure **206** disposed on a surface of the insulating layer **205** facing away from the touch layer **204**.

According to an embodiment of the present invention, the touch layer **204** is disposed between the pixel array structure **206** and the first substrate **201**. Only a photoetching process and a deposition process need to be additionally performed in the process for manufacturing a non-touch liquid crystal display device by the manufacturers of the liquid crystal display panel. That is, before the pixel array structure **206** is formed on the surface of the first substrate **201**, a touch layer **204** is formed on the surface of the first substrate **201**, then a touch electrode is formed on the touch layer **204** by using the photoetching process, and an insulating layer **205** is finally formed on the surface of the touch electrode to complete the touch liquid crystal display device according to an embodiment of the present invention. In this way, the process for manufacturing the touch liquid crystal display device according to an embodiment of the present invention is simple.

In order to make the objects, features and advantages of the present invention better understandable, specific embodiments of the present invention will be described in detail below in conjunction with the accompanying drawings.

Specific details will be set forth in the following descriptions of the present invention. However, the present invention may also be implemented in other ways different from the way described herein. Therefore, the present invention is not limited to the specific embodiments disclosed hereinafter.

An Embodiment

As illustrated in FIG. 2, a touch liquid crystal display device according to an embodiment of the present invention includes: a first substrate **201** and a second substrate **202**, where the first substrate **201** and the second substrate **202** are opposite to each other, and a liquid crystal layer **203** disposed between the first substrate **201** and the second substrate **202**. A touch layer **204** is disposed on a surface of the first substrate **201** facing the liquid crystal layer **203**, an insulating layer **205** is disposed on a surface of the touch layer **204** and covers the touch layer **204**, and a pixel array structure **206** is disposed on a surface of the insulating layer **205** facing away from the touch layer **204**. The second substrate **202** includes a light-blocking layer (not shown in the figures) disposed on a side of the second substrate **202** facing the liquid crystal layer **203**, and a color filter layer (not shown in the figures) disposed on a side of the light-blocking layer facing away from the second substrate **202**.

The process for manufacturing the touch liquid crystal display device according to the embodiment of the present invention includes: providing a first substrate **201**; forming a touch layer **204** on a surface of the first substrate **201**; etching the touch layer **204** to form a touch electrode; forming an insulating layer **205** on a surface of the touch layer **204**; and forming a pixel array structure **206** on a surface of the insulating layer **205**; then sealing the above obtained structure. The pre-produced color filter structure (i.e., the second substrate **202**) obtained from a manufacture of the color filter structure and the liquid crystal layer **203** are integrated together to obtain the touch liquid crystal display device.

Therefore, to obtain the touch liquid crystal display device according to the embodiment of the present invention, only the filming process and photoetching process of the touch panel and the deposition process of the insulating layer need to be additionally performed in the process for manufacturing a non-touch touch liquid crystal display device by the manufacturers of the liquid crystal display panel. In other words, before the pixel array structure **206** is formed on the surface of the first substrate **201**, a conductive film is formed on the surface of the first substrate **201**, then a touch layer **204** is formed by using the photoetching process, and an insulating layer **205** is finally formed on the surface of the touch electrode, therefore the touch liquid crystal display device according to an embodiment of the present invention is obtained. The process for manufacturing the touch liquid crystal display device is simple.

It should be noted that the touch layer and display panel are performed at the backside of the touch liquid crystal display device according to an embodiment of the present invention, that is, the touch layer and display panel are performed on a surface of the first substrate **201** facing away from the liquid crystal layer **203**. Therefore, material of the insulating layer **205** disposed between the touch layer **204** and the pixel array structure **206** includes transparent materials. In one embodiment according to an embodiment of the present invention, the insulating layer **205** is a silicon nitride layer or an organic film.

In addition, since the touch layer and display panel are performed at the backside of the touch liquid crystal display device according to an embodiment of the present invention,

there will be some light reflection if the driving electrodes and the sensing electrodes in the touch layer include common metal material. Therefore, in the embodiment of the present invention, the driving electrodes and the sensing electrodes are preferably transparent ITO electrodes or metal electrodes of non-reflective material such as chromium electrodes, thereby improving the display effect of the touch liquid crystal display device.

It should be noted that the driving electrodes and the sensing electrodes being transparent ITO electrodes or metal electrodes made of non-reflective material are only preferred embodiment. In other embodiments of the present invention, the driving electrodes and the sensing electrodes may include light-reflective material, and the light reflection effect of the touch liquid crystal display device is weakened and the display effect of the touch liquid crystal display device is improved as long as a suitable polarizer is selected. The present invention is not limited thereto.

In addition, in the touch liquid crystal display device according to the embodiment of the present invention, the touch layer **204** is disposed between the first substrate **201** and the pixel array structure **206**, so that the pixel array structure **206** and the touch layer **204** may share a same driving circuit. Therefore, the size of the touch liquid crystal display device is reduced. Moreover, in the detection of the touch layer **204** in the touch liquid crystal display device, the detecting circuit of the touch layer **204** is easy to be integrated with the driving circuit of the touch liquid crystal display device.

In summary, the touch liquid crystal display device according to the embodiment of the present invention not only has a simple manufacturing process but also a reduced size.

Another Embodiment

Referring to FIGS. 2 to 4, FIG. 2 is a cross-section structural schematic diagram of a touch liquid crystal display device according to the present embodiment, FIG. 3 illustrates a structure of a driving electrodes or a sensing electrodes in a touch layer **204** of FIG. 2, FIG. 4A illustrates a structure of the touch layer **204**, and FIG. 4B illustrates another structure of the touch layer **204**.

In the touch liquid crystal display device according to an embodiment of the present invention, the touch layer **204** is a bi-layered structure. The touch layer **204** includes multiple driving electrodes and multiple sensing electrodes, and the driving electrodes are disposed in a same layer as the sensing electrodes. However, the adjacent driving electrodes or the adjacent sensing electrodes are electrically connected by a bridge structure, and the bridge structure is disposed in a different layer from the driving electrodes and the sensing electrodes.

As illustrated in FIG. 3, each of the driving electrodes and the sensing electrodes includes multiple horizontal metal wires **31** and multiple vertical metal wires **32** interleaved with each other. Moreover, the horizontal metal wires **31** and the vertical metal wires **32** of the driving electrodes and the sensing electrodes overlap with a light-blocking layer in the color filter structure (i.e., the second substrate **202** in FIG. 2). That is, the horizontal metal wires **31** and the vertical metal wires **32** do not occupy an aperture opening ratio independently. Regions surrounded by the horizontal metal wires **31** and the vertical metal wires **32** overlap with display regions of pixel units of the pixel array structure **206**, therefore the aperture opening ratio of the touch liquid crystal display device is increased.

In the embodiment, the driving mode of the touch liquid crystal display device is Fringe Field Switching (FFS) mode.

However, the present invention is not limited to the specific embodiment, and the driving mode of the touch liquid crystal display device may also be other modes. As illustrated in FIGS. 4A and 4B, the pixel array structure **206** includes a gate electrode metal layer **41**, a source/drain electrode metal layer **42** and a common electrode layer **43** in a sequence from bottom to top. The gate electrode metal layer **41** includes multiple horizontal driving lines, the source/drain electrode metal layer **42** includes multiple vertical driving lines, and the common electrode layer **43** is a layer structure in an entire surface. In the present embodiment, the driving electrodes and the sensing electrodes are interleaved with each other, and the driving electrodes and the sensing electrodes are insulated from each other.

As illustrated in FIGS. 4A and 4B, the touch layer **204** according to the present embodiment is a bi-layer structure. The driving electrode includes multiple driving sub-electrodes insulated from each other, the sensing electrode includes multiple sensing sub-electrodes insulated from each other, and the multiple driving sub-electrodes and the multiple sensing sub-electrodes are formed in a same metal layer. Specifically, as illustrated in FIG. 4A, a touch electrode **44** is a driving electrode, a touch electrode **45** is a sensing electrode, the adjacent driving sub-electrodes are electrically connected via a bridge structure **46** disposed in a different layer from the driving sub-electrodes, and the adjacent sensing sub-electrodes are electrically connected via a metal wire disposed in a same layer as the sensing sub-electrodes. As illustrated in FIG. 4B, a touch electrode **44** is a sensing electrode, a touch electrode **45** is a driving electrode, the adjacent sensing sub-electrodes are electrically connected via a bridge structure, where the bridge structure is disposed in a different layer from the sensing sub-electrodes, and the adjacent driving sub-electrodes are electrically connected via a metal lead, where the metal lead is disposed in a same layer as the driving sub-electrodes.

In the embodiment, the bridge structure **46** may be an interconnect metal in the same layer as the gate electrode metal layer **41** in the pixel array structure **206**, as illustrated in FIG. 4A; or the bridge structure **46** may be an interconnect metal in the same layer as the source/drain electrode metal layer **42** in the pixel array structure **206**, as illustrated in FIG. 4B. In the specific production processes, just one step of photoetching is needed to form both the gate electrode metal layer **41** and the bridge structure **46** or form both the source/drain electrode metal layer **42** and the bridge structure **46**. Therefore, the process for manufacturing the touch liquid crystal display device is further simplified, and the thickness of the touch liquid crystal display device is reduced.

Similarly, in the case where the touch electrode **44** is the sensing electrode and the touch electrode **45** is the driving electrode, the sensing electrode **44** includes multiple sensing sub-electrodes insulated from each other, and the adjacent sensing sub-electrodes are electrically connected via a bridge structure **46** disposed in a different metal layer from the sensing sub-electrodes. The bridge structure **46** may be metal in the same layer as the gate electrode metal layer **41** in the pixel array structure **206**, as illustrated in FIG. 4A; or may be metal in the same layer as the source/drain electrode metal layer **42** in the pixel array structure **206**, as illustrated in FIG. 4B. In the specific production processes, just one step of photoetching is needed to form both the gate electrode metal layer **41** and the bridge structure **46** or form both the source/drain electrode metal layer **42** and the bridge structure **46**. Therefore, the process for manufacturing the touch liquid crystal display device is further simplified, and the thickness of the touch liquid crystal display device is reduced.

In summary, in the touch liquid crystal display device according to the present embodiment of the present invention, the bridge structure **46** is metal in the same layer as the gate electrode metal layer **41** in the pixel array structure **206**, or is metal in the same layer as the source/drain electrode metal layer **42** in the pixel array structure **206**. Therefore, in the specific production processes, just one step of photoetching is needed to form both the gate electrode metal layer **41** and the bridge structure **46** or form both the source/drain electrode metal layer **42** and the bridge structure **46**. Therefore, the process for manufacturing the touch liquid crystal display device is further simplified, and the thickness of the touch liquid crystal display device is reduced.

Another Embodiment

In conjunction with FIGS. **1** to **3** as described above, in the touch liquid crystal display device according to an embodiment of the present invention, the insulating layer **205** is disposed between the touch electrode in the touch layer **204** and the gate electrode metal layer **41**. Therefore, a parasitic capacitance may be generated between the touch electrode in the touch layer **204** and the gate electrode metal layer **41**. Similarly, the insulating layer **205** is disposed between the touch electrode in the touch layer **204** and the source/drain electrode metal layer **42** and between the touch electrode in the touch layer **204** and the common electrode layer **43**, therefore parasitic capacitances may be generated between the touch electrode in the touch layer **204** and the source/drain electrode metal layer **42**, and between the touch electrode in the touch layer **204** and the common electrode layer **43**.

FIG. **5** illustrates a schematic diagram of an ideal equivalent circuit of the touch liquid crystal display device of FIG. **2**. The equivalent circuit includes: a signal source **51**, a driving electrodes resistance **52**, a mutual capacitance **53** between a driving electrode and a sensing electrode, a sensing electrode resistance **55**, and a detecting circuit **56**. The signal source **51** provides a driving signal to driving electrodes, and the detecting circuit **56** is used for signal detection. In the case where a finger touches a touch panel, part of current flows into the finger, the mutual capacitance **53** between the driving electrodes and the sensing electrodes is changed, and the touch position of the finger is determined according to the small current change caused by the change in the mutual capacitance **53** detected by the detecting circuit **56**.

The parasitic capacitance between the common electrode layer **43** and the touch electrode in the touch layer according to the embodiment of FIG. **4** is taken as an example. The common electrode layer **43** has a layer structure in an entire surface, and in the case where the liquid crystal display device is used for displaying, a large driving parasitic capacitance **54** is generated between the common electrode layer **43** and the driving electrodes, and a large sensing parasitic capacitance **60** is generated between the common electrode layer **43** and the sensing electrodes at the same time, as illustrated in FIG. **6**.

When the signal source **51** provides an alternating current (AC) signal, the AC signal enters into the detecting circuit **56** via the driving electrodes resistance **52**, the mutual capacitance **53** and the sensing electrodes resistance **55**. The large driving parasitic capacitance **54** and the large sensing parasitic capacitance **60** have small condensance compared with the AC signal transmitted from the signal source **51**, and a resistance **57** of the common electrode layer **43** and an inductance **58** of the common electrode layer **43** prevent the AC signal from flowing into the ground terminal. Therefore, the AC signal sequentially passes through the driving parasitic

capacitance **54** and the sensing parasitic capacitance **60**, where the driving parasitic capacitance **54** and the sensing parasitic capacitance **60** have small condensance, thus a current path **59** is formed. After the AC signal passes through the current path **59**, a large base signal is formed in the detecting circuit **56**. The signal corresponding to the change in the mutual capacitance **53** is generally small and thus is easy to be neglected with respect to the large base signal, therefore the detecting circuit **56** may be unable to detect the signal corresponding to the change in the mutual capacitance **53**, leading to a failed detection. Thus, the liquid crystal display device has low touch sensitivity.

Similarly, the parasitic capacitance generated between the gate electrode metal layer **41** and the touch electrode in the touch layer **204** and the parasitic capacitance generated between the source/drain electrode metal layer **42** and the touch electrode in the touch layer **204** may also affect the mutual capacitance **53** generated between the driving electrodes and the sensing electrodes, weaken the valid signal in the detecting circuit **56**, and reduce the touch sensitivity of the touch liquid crystal display device.

In order to solve the above-mentioned problem, the touch liquid crystal display device is provided according to the present embodiment, where the common electrode layer **43** in the pixel array structure **206** includes multiple common electrodes whose arrangement pattern is the same as that of the electrodes in the touch layer.

It should be noted that the arrangement pattern of the common electrodes in the common electrode layer **43** being the same as the arrangement pattern of the electrodes in the touch layer refers to that: the common electrode layer **43** includes multiple block common electrodes, the shape of the profile of each of the block common electrodes is the same as the shape of the profile of the electrode in the touch layer disposed above the block common electrode, and the multiple block common electrodes in the common electrode layer **43** overlap with the electrodes in the touch layer disposed above the multiple block common electrodes in a light-transmission direction.

It should be noted that the block electrode of the common electrode is an entire block, which is unlike the electrode in the touch layer shown in FIG. **3** including horizontal metal wires **31** and vertical metal wires **32**.

It should be understood that the horizontal metal wires **31** and the vertical metal wires **32** of the driving electrodes and the sensing electrodes of the touch panel are overlapped with the light-blocking layer in the color filter structure (i.e., the second substrate **202** in FIG. **2**), and the regions surrounded by the horizontal metal wires **31** and the vertical metal wires **32** are overlapped with the display regions of pixel units of the pixel array structure **206**, as described above. The common electrode includes multiple entire block electrodes. Thus the common electrode is disposed in each of the pixel units for driving the pixel units to display. The multiple block common electrodes are disconnected with each other, and the disconnected portion corresponds to the light-blocking layer of the color filter structure. A common signal may be input to the multiple block common electrodes by setting signal lines to drive the pixel units.

Since the driving electrodes and the sensing electrodes in the touch layer are separated from each other and the pattern of the multiple block common electrodes in the common electrode layer **43** is the same as the pattern of the electrodes in the touch layer, the pattern of the multiple block common electrodes in the common electrode layer **43** corresponding to the driving electrodes and the pattern of the multiple block common electrodes in the common electrode layer **43** corre-

sponding to the sensing electrodes are also separated or disconnected. That is, the current path between the driving parasitic capacitance **54** and the sensing parasitic capacitance **60** is disconnected, thus the AC signal, which is sent from the signal source **51** and reaches the detecting circuit **56** via the driving parasitic capacitance **54** and the sensing parasitic capacitance **60**, is greatly reduced. Therefore, no large base signal is formed at the detecting circuit **56**, thereby weakening the influence of the parasitic capacitance generated between the common electrode layer and the touch electrode in the touch layer **204** on the mutual capacitance **53** between the driving electrodes and the sensing electrodes, enhancing the valid signal in the detecting circuit **56**, and increasing the touch sensitivity of the touch liquid crystal display device.

Another Embodiment

As described in the above embodiments, the horizontal metal wires **31** and the vertical metal wires **32** in the driving electrodes and the sensing electrodes overlap with the light-blocking layer in the color filter structure (i.e., the second substrate **202** in FIG. 2), therefore the horizontal metal wires **31** and the vertical metal wires **32** do not occupy the aperture opening ratio independently. A large number of driving lines formed in the gate electrode or source/drain electrode metal layer are disposed at the portion of the pixel array structure **206** disposed on the surface of the first substrate **201** corresponding to the light-blocking layer in the color filter structure, therefore a large parasitic capacitance may be generated between the driving lines and the horizontal metal wires or the vertical metal wires of the driving electrodes and the sensing electrodes.

In order to further enhance the valid signal in the detecting circuit **56** and to increase the touch sensitivity of the touch liquid crystal display device, in the touch liquid crystal display device according to the embodiment, the number of the vertical metal wires **32** in the touch layer **204** is less than the number of the vertical metal driving lines in the pixel array structure **206**, in addition, or alternatively, the number of the horizontal metal wires **31** in the touch layer **204** is less than the number of the horizontal metal driving lines in the pixel array structure **206**.

FIG. 7A illustrates a structural schematic diagram of the driving electrodes or the sensing electrodes in the prior art, and FIG. 7B illustrates a structural schematic diagram of the driving electrodes or the sensing electrodes according to the embodiment of the present invention.

Therefore, the parasitic capacitance generated between the gate electrode metal layer **41** and the touch electrode in the touch layer **204** and the parasitic capacitance generated between the source/drain electrode metal layer **42** and the touch electrode in the touch layer **204** may also affect the mutual capacitance **53** between the driving electrodes and the sensing electrodes, therefore, the valid signal in the detecting circuit **56** is weakened and the touch sensitivity of the touch liquid crystal display device is reduced.

Specifically, the parasitic capacitance is generated between the gate electrode metal layer **41** and the touch electrode in the touch layer **204**, this is because the gate electrode metal layer **41** includes multiple horizontal driving lines corresponding to the horizontal metal wires **31** in the driving electrodes and the sensing electrodes respectively and are disposed right above the horizontal metal wires **31**, therefore, a parasitic capacitance is generated between each of the horizontal metal wires **31** and the corresponding horizontal driving line. The parasitic capacitance generated between the horizontal metal wire **31** in the driving electrodes and the corresponding hori-

zontal driving line is the driving parasitic capacitance **54**, and the parasitic capacitance generated between the horizontal metal wire **31** in the sensing electrodes and the corresponding horizontal driving line is the sensing parasitic capacitance **60**. Therefore, a current path **59** is formed between the driving electrodes and the sensing electrodes, therefore, the base signal in the detecting circuit **56** is increased and the touch sensitivity of the touch liquid crystal display device is reduced.

However, in the present embodiment, the number of the horizontal metal wires **31** in the touch layer **204** is less than the number of the horizontal driving lines in the pixel array structure **206**, and there has no one-to-one correspondence between the horizontal metal wires **31** and the horizontal driving lines. Therefore, the right opposite area between the horizontal metal wires **31** in the touch layer **204** and the horizontal driving lines is reduced as a whole, the parasitic capacitance generated between the horizontal metal wires **31** in the touch layer **204** and the horizontal driving lines is reduced, the influence of the parasitic capacitance generated between the horizontal metal wires **31** in the touch layer **204** and the horizontal driving lines on the mutual capacitance **53** between the driving electrodes and the sensing electrodes is weakened, the valid signal in the detecting circuit **56** is enhanced, and the touch sensitivity of the touch liquid crystal display device is increased.

It should be noted that in the present embodiment the number of the horizontal metal wires **31** in the touch layer **204** being less than the number of the horizontal driving lines in the pixel array structure **206** may be explained as follows:

the number of the horizontal metal wires **31** in the driving electrodes is less than the number of the horizontal driving lines in the pixel array structure **206**, thus the driving parasitic capacitance **54** between the horizontal metal wires **31** in the driving electrodes and the horizontal driving lines is reduced, the influence of the driving parasitic capacitance **54** on the mutual capacitance **53** between the driving electrodes and the sensing electrodes is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the horizontal metal wires **31** in the touch layer **204** being less than the number of the horizontal driving lines in the pixel array structure **206** may also be explained as follows: the number of the horizontal metal wires **31** in the sensing electrodes is less than the number of the horizontal driving lines in the pixel array structure **206**, thus the sensing parasitic capacitance **60** between the horizontal metal wires **31** in the sensing electrodes and the horizontal driving lines is reduced, the influence of the sensing parasitic capacitance **60** on the mutual capacitance **53** between the driving electrodes and the sensing electrodes is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the horizontal metal wires **31** in the touch layer **204** being less than the number of the horizontal driving lines in the pixel array structure **206** may further be explained as follows: both the number of the horizontal metal wires **31** in the driving electrodes and the number of the horizontal metal wires **31** in the sensing electrodes are less than the number of the horizontal driving lines in the pixel array structure **206**, thus both the driving parasitic capacitance **54** between the horizontal metal wires **31** in the driving electrodes and the horizontal driving lines and the sensing parasitic capacitance **60** between the horizontal metal wires **31** in the sensing electrodes and the horizontal driving lines are reduced, the influence of both the driving parasitic capacitance **54** and the sensing parasitic capacitance **60** on the mutual capacitance **53** is weakened, and the touch sensitivity of the touch liquid crystal display device is further increased.

Preferably, in the embodiment, the number of the horizontal metal wires **31** included in the driving electrodes in addition or alternatively the sensing electrodes ranges from 2 to 10, to ensure a valid touch area of the touch layer **204** in the touch liquid crystal display device while reducing the influence of the parasitic capacitance between the horizontal metal wires **31** in the touch layer **204** and the horizontal driving lines on the mutual capacitance **53**, enhancing the valid signal in the detecting circuit **56**, and increasing the touch sensitivity of the touch liquid crystal display device.

Preferably, in the embodiment of the present invention, the horizontal metal wires **31** in the driving electrodes in addition or alternatively the sensing electrodes are evenly arranged, thus the consistency of sensitivity of each touch point in the touch layer **204** is ensured.

Similarly, a parasitic capacitance is generated between the source/drain electrode metal layer **42** and the touch electrode in the touch layer **204**, this is because the source/drain electrode metal layer **42** includes multiple vertical driving lines corresponding to the vertical metal wires **32** in the driving electrodes and the sensing electrodes respectively and are located right above the vertical metal wires **32**, therefore, a parasitic capacitance is generated between each of the vertical metal wires **32** and the corresponding vertical driving line. The parasitic capacitance generated between the vertical metal wire **32** in the driving electrodes and the corresponding vertical driving line is the driving parasitic capacitance **54**, and the parasitic capacitance generated between the vertical metal wire **32** in the sensing electrodes and the corresponding vertical driving line is the sensing parasitic capacitance **60**. Therefore, a current path **59** is formed between the driving electrodes and the sensing electrodes, thus the base signal in the detecting circuit **56** is increased, and the touch sensitivity of the touch liquid crystal display device is reduced.

However, in the embodiment, the number of the vertical metal wires **32** in the touch layer **204** is less than the number of the vertical driving lines in the pixel array structure **206**, and there has no one-to-one correspondence between the vertical metal wires **32** and the vertical driving lines. Therefore, the right opposite area between the vertical metal wires **32** in the touch layer **204** and the vertical driving lines is reduced as a whole, the parasitic capacitance generated between the vertical metal wires **32** in the touch layer **204** and the vertical driving lines and the vertical driving lines is reduced, the influence of the parasitic capacitance generated between the vertical metal wires **32** in the touch layer **204** and the vertical driving lines on the mutual capacitance **53** between the driving electrodes and the sensing electrodes is weakened, the valid signal in the detecting circuit **56** is enhanced, and the touch sensitivity of the touch liquid crystal display device is increased.

It should be noted that in the present embodiment the number of the vertical metal wires **32** in the touch layer **204** being less than the number of the vertical driving lines in the pixel array structure **206** may be explained as follows:

the number of the vertical metal wires **32** in the driving electrodes is less than the number of the vertical driving lines in the pixel array structure **206**, therefore, the driving parasitic capacitance **54** between the vertical metal wires **32** in the driving electrodes and the vertical driving lines is reduced, the influence of the driving parasitic capacitance **54** on the mutual capacitance **53** between the driving electrodes and the sensing electrodes is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the vertical metal wires **32** in the touch layer **204** being less than the number of the vertical driving lines in the pixel array structure **206** may also be explained as follows: the number of the vertical metal wires **32** in the sensing

electrodes is less than the number of the vertical driving lines in the pixel array structure **206**, therefore, the sensing parasitic capacitance **60** between the vertical metal wires **32** in the sensing electrodes and the vertical driving lines is reduced, the influence of the sensing parasitic capacitance **60** on the mutual capacitance **53** between the driving electrodes and the sensing electrodes is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the vertical metal wires **32** in the touch layer **204** being less than the number of the vertical driving lines in the pixel array structure **206** may further be explained as follows: both the number of the vertical metal wires **32** in the driving electrodes and the number of the vertical metal wires **32** in the sensing electrodes are less than the number of the vertical driving lines in the pixel array structure **206**, therefore, both the driving parasitic capacitance **54** between the vertical metal wires **32** in the driving electrodes and the vertical driving lines and the sensing parasitic capacitance **60** between the vertical metal wires **32** in the sensing electrodes and the vertical driving lines are reduced, the influence of both the driving parasitic capacitance **54** and the sensing parasitic capacitance **60** on the mutual capacitance **53** is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

Preferably, in the embodiment, the number of the vertical metal wires **32** included in the driving electrodes in addition or alternatively the sensing electrodes ranges from 2 to 10, to ensure a valid touch area of the touch layer **204** in the touch liquid crystal display device while reducing the influence of the parasitic capacitance between the vertical metal wires **32** in the touch layer **204** and the vertical driving lines on the mutual capacitance **53**, enhancing the valid signal in the detecting circuit **56** and increasing the touch sensitivity of the touch liquid crystal display device.

Preferably, in the embodiment of the present invention, the vertical metal wires **32** in the driving electrodes in addition or alternatively the sensing electrodes are evenly arranged, thus the consistency of sensitivity of each touch point in the touch layer **204** is ensured.

It should be noted that in the present embodiment, in order to ensure the aperture opening ratio of the touch liquid crystal display device, the vertical metal wires **32** and the vertical driving lines in the pixel array structure **206** may overlap with each other, in addition or alternatively the horizontal metal wires **31** and the horizontal driving lines in the pixel array structure **206** may be arranged to be overlapped with each other. However, in order to increase the touch sensitivity of the touch liquid crystal display device, the vertical metal wires **32** and the vertical driving lines in the pixel array structure **206** may be arranged in a stagger manner, in addition or alternatively the horizontal metal wires **31** and the horizontal driving lines in the pixel array structure **206** may be arranged in a stagger manner, therefore, the aperture opening ratio of the touch liquid crystal display device is reduced.

In summary, in the touch liquid crystal display device according to the present embodiment of the present invention, the number of the horizontal metal wires **31** in the touch layer **204** in addition or alternatively the number of the vertical metal wires **32** in the touch layer **204** are reduced, the vertical metal wires **32** and the vertical driving lines in the pixel array structure **206** are arranged in an interleaved way, in addition or alternatively the horizontal metal wires **31** and the horizontal driving lines in the pixel array structure **206** are arranged in a stagger manner, and the common electrode layer **43** includes multiple common electrodes, where arrangement pattern of the multiple common electrodes is the same as that of the electrodes in the touch layer **204**, therefore, the para-

sitic capacitance between the gate electrode metal layer 41 and the touch layer 204 is reduced, the parasitic capacitance between the source/drain electrode metal layer 42 and the touch layer 204 is reduced, and thus the touch sensitivity of the touch liquid crystal display device is increased.

Another Embodiment

As illustrated in FIG. 8, this embodiment differs from the embodiments of FIGS. 2-4 in that, the touch layer 204 in the touch liquid crystal display device is a single layer structure, where both multiple block driving electrodes 71 and multiple strip sensing electrodes 72 are formed in the same layer and are electrically connected via external leads. Both of the block driving electrodes 71 and the strip sensing electrodes 72 include metal grids formed by multiple horizontal metal wires 31 and multiple vertical metal wires 32 interleaved with each other.

It should be noted that in an embodiment of the present invention, the driving electrodes 71 and the sensing electrodes 72 adjacent to each other in the touch layer 204 may be disposed in an interleaved way in the column direction, as illustrated in FIG. 7. In another embodiment of the present invention, the driving electrodes 71 and the sensing electrodes 72 adjacent to each other in the touch layer 204 may be disposed in an interleaved way in the row direction, as illustrated in FIG. 10.

In the case where the driving electrodes 71 and the sensing electrodes 72 adjacent to each other in the touch layer 204 are disposed in an interleaved way in the column direction, parasitic capacitances are generated between the touch layer 204 and the gate electrode metal layer 41, between the touch layer 204 and the source/drain electrode metal layer 42 and between the touch layer 204 and the common electrode layer 43, since the distances between the touch layer 204 and the gate electrode metal layer 41, between the touch layer 204 and the source/drain electrode metal layer 42 and between the touch layer 204 and the common electrode layer 43 are small. The parasitic capacitance between the touch layer 204 and the gate electrode metal layer 41 is generated between the horizontal metal wires 31 in the touch layer 204 and the horizontal driving line in the gate electrode metal layer 41. The parasitic capacitance between the touch layer 204 and the source/drain electrode metal layer 42 is generated between the vertical metal wires 32 in the touch layer 204 and the vertical driving lines in the source/drain electrode metal layer 42.

In the present embodiment, the driving electrodes 71 and the sensing electrodes 72 in the touch layer 204 are arranged in an interleaving way in the column direction, and the mutual capacitance 53 is generated between the driving electrodes 71 and the sensing electrodes 72, that is, the mutual capacitance 53 is generated between the horizontal electrodes. Moreover, the parasitic capacitance generated between the vertical metal wires 32 in the touch layer 204 and the vertical driving lines in the source/drain electrode metal layer 42 is generated between the vertical electrodes. Therefore, in the present embodiment, the parasitic capacitance between the touch layer 204 and the source/drain metal layer 42 has no significant influence on the mutual capacitance 53, that is, the touch sensitivity of the touch liquid crystal display device will not be greatly reduced.

Therefore, in order to increase the touch sensitivity of the touch liquid crystal display device, the number of the horizontal metal wires 31 in the touch layer 204 may be less than the number of the horizontal driving lines in the pixel array structure 206, to make the horizontal metal wires 31 in the touch layer 204 and the horizontal driving lines in the gate

electrode metal layer 41 no longer have the one-to-one correspondence, therefore, the right opposite area between the horizontal metal wires 31 in the touch layer 204 and the horizontal driving lines is reduced as a whole, the parasitic capacitance generated between the horizontal metal wires 31 in the touch layer 204 and the horizontal driving lines is reduced, the influence of the parasitic capacitance generated between the horizontal metal wires 31 in the touch layer 204 and the horizontal driving lines on the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is weakened, the valid signal in the detecting circuit 56 is enhanced, and the touch sensitivity of the touch liquid crystal display device is increased.

It should be noted that in the present embodiment, the number of the horizontal metal wires 31 in the touch layer 204 being less than the number of the horizontal driving lines in the pixel array structure 206 may be explained as follows:

The number of the horizontal metal wires 31 in the driving electrodes 71 is less than the number of the horizontal driving lines in the pixel array structure 206, therefore, the driving parasitic capacitance 54 between the horizontal metal wires 31 in the driving electrodes 71 and the horizontal driving lines is reduced, the influence of the driving parasitic capacitance 54 on the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the horizontal metal wires 31 in the touch layer 204 being less than the number of the horizontal driving lines in the pixel array structure 206 may also be explained as follows: the number of the horizontal metal wires 31 in the sensing electrodes 72 is less than the number of the horizontal driving lines in the pixel array structure 206, therefore, the sensing parasitic capacitance 60 between the horizontal metal wires 31 in the sensing electrodes 72 and the horizontal driving lines is reduced, the influence of the sensing parasitic capacitance 60 on the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the horizontal metal wires 31 in the touch layer 204 being less than the number of the horizontal driving lines in the pixel array structure 206 may further be explained as follows: both the number of the horizontal metal wires 31 in the driving electrodes 71 and the number of the horizontal metal wires 31 in the sensing electrodes 72 are less than the number of the horizontal driving lines in the pixel array structure 206, therefore, both the driving parasitic capacitance 54 between the horizontal metal wires 31 in the driving electrodes 71 and the horizontal driving lines and the sensing parasitic capacitance 60 between the horizontal metal wires 31 in the sensing electrodes 72 and the horizontal driving lines are reduced, the influence of both the driving parasitic capacitance 54 and the sensing parasitic capacitance 60 on the mutual capacitance 53 is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

Preferably, in the embodiment, the number of the horizontal metal wires 31 included in the driving electrodes 71 in addition or alternatively the sensing electrodes 72 ranges from 2 to 10, to ensure a valid touch area of the touch layer 204 in the touch liquid crystal display device while reducing the influence of the parasitic capacitance between the horizontal metal wires 31 in the touch layer 204 and the horizontal driving lines on the mutual capacitance 53, enhancing the valid signal in the detecting circuit 56, and increasing the touch sensitivity of the touch liquid crystal display device.

Preferably, in the embodiment of the present invention, the horizontal metal wires 31 in the driving electrodes 71 in addition or alternatively the sensing electrodes 72 are evenly arranged, thus the consistency of sensitivity of each touch point in the touch layer 204 is ensured.

It should be noted that in the embodiment, in order to ensure the aperture opening ratio of the touch liquid crystal display device, the horizontal metal wires 31 and the horizontal driving lines in the pixel array structure 206 may overlap with each other. However, in order to increase the touch sensitivity of the touch liquid crystal display device, the horizontal metal wires 31 and the horizontal driving lines in the pixel array structure 206 may be arranged in a staggered manner, therefore, the aperture opening ratio of the touch liquid crystal display device is reduced.

In summary, in the touch liquid crystal display device according to the present embodiment of the present invention, the number of the horizontal metal wires 31 in the touch layer 204 is reduced, and the horizontal metal wires 31 and the horizontal driving lines in the pixel array structure 206 are disposed in a staggered manner, therefore, the parasitic capacitance between the gate electrode metal layer 41 and the touch layer 204 is reduced, and the touch sensitivity of the touch liquid crystal display device is increased.

Another Embodiment

In order to further increase the touch sensitivity of the touch liquid crystal display device, the common electrode layer 43 in the pixel array structure 206 includes multiple vertically-arranged common electrode lines in the touch liquid crystal display device according to the present embodiment as illustrated in FIG. 9.

As illustrated in FIG. 8, in the touch liquid crystal display device according to the embodiment, multiple block driving electrodes 71 and multiple strip sensing electrodes 72 are formed on the touch layer 204, are disposed in an interleaved way in the column direction and are electrically connected via external leads. Both of the block driving electrodes 71 and the strip sensing electrodes 72 include metal grids formed by multiple horizontal metal wires 31 and multiple vertical metal wires 32 crossing each other.

The driving electrodes 71 and the sensing electrodes 72 in the touch layer 204 are disposed in an interleaved way in the column direction, and the mutual capacitance 53 is generated between the driving electrodes 71 and the sensing electrodes 72, that is, the mutual capacitance 53 is generated between the adjacent horizontal electrodes. However, in the present embodiment, the common electrode layer 43 in the pixel array structure 206 includes multiple vertically-arranged common electrode lines (Vcom lines). Specifically, the common electrodes of each column of pixels are connected together to form a common electrode line, that is, there is no horizontal common electrode between the adjacent driving electrodes 71 and sensing electrodes 71 for coupling the driving electrodes 71 to the sensing electrodes 72 to form a parasitic capacitance, therefore, the influence of the parasitic capacitance generated between the touch layer 204 and the common electrode layer 43 on the mutual capacitance 53 generated between the driving electrodes 71 and the sensing electrodes 72 is greatly weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

Another Embodiment

The touch liquid crystal display device of this embodiment differs from that of the embodiment of FIG. 8 in that, the

adjacent driving electrodes 71 and sensing electrodes 72 in the touch layer 204 are arranged in an interleaved way in the row direction, as illustrated in FIG. 10.

In the case where the driving electrodes 71 and the sensing electrodes 72 adjacent to each other in the touch layer 204 are arranged in an interleaved way in the row direction, the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is generated between adjacent vertically-arranged electrodes. Moreover, the parasitic capacitance generated between the horizontal metal wires 31 in the touch layer 204 and the horizontal driving lines in the gate electrode metal layer 41 is generated between horizontal electrodes. Therefore, in the present embodiment, the parasitic capacitance between the touch layer 204 and the gate electrode metal layer 41 will not greatly affect the mutual capacitance 53, and the touch sensitivity of the touch liquid crystal display device will not be reduced.

Therefore, in order to increase the touch sensitivity of the touch liquid crystal display device according to the embodiment, the number of the vertical metal wires 32 in the touch layer 204 may be less than the number of the vertical driving lines in the pixel array structure 206, and the vertical metal wires 32 in the touch layer 204 and the vertical driving lines in the source/drain electrode metal layer 42 no longer have the one-to-one correspondence, therefore, the parasitic capacitance between the vertical metal wires 32 in the touch layer 204 and the vertical driving lines is reduced, the influence of the parasitic capacitance between the vertical metal wires 32 in the touch layer 204 and the vertical driving lines on the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is weakened, the valid signal in the detecting circuit 56 is enhanced, and the touch sensitivity of the touch liquid crystal display device is increased.

Similarly, in the embodiment, the number of the vertical metal wires 32 in the touch layer 204 being less than the number of the vertical driving lines in the pixel array structure 206 may be explained as follows:

The number of the vertical metal wires 32 in the driving electrodes 71 is less than the number of the vertical driving lines in the pixel array structure 206, therefore, the driving parasitic capacitance 54 between the vertical metal wires 32 in the driving electrodes 71 and the vertical driving lines is reduced, the influence of the driving parasitic capacitance 54 on the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the vertical metal wires 32 in the touch layer 204 being less than the number of the vertical driving lines in the pixel array structure 206 may also be explained as follows: the number of the vertical metal wires 32 in the sensing electrodes 72 is less than the number of the vertical driving lines in the pixel array structure 206, therefore, the sensing parasitic capacitance 60 between the vertical metal wires 32 in the sensing electrodes 72 and the vertical driving lines is reduced, the influence of the sensing parasitic capacitance 60 on the mutual capacitance 53 between the driving electrodes 71 and the sensing electrodes 72 is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

The number of the vertical metal wires 32 in the touch layer 204 being less than the number of the vertical driving lines in the pixel array structure 206 may further be explained as follows: both the number of the vertical metal wires 32 in the driving electrodes 71 and the number of the vertical metal wires 32 in the sensing electrodes 72 are less than the number of the vertical driving lines in the pixel array structure 206,

therefore, both the driving parasitic capacitance **54** between the vertical metal wires **32** in the driving electrodes **71** and the vertical driving lines and the sensing parasitic capacitance **60** between the vertical metal wires **32** in the sensing electrodes **72** and the vertical driving lines are reduced, the influence of both the driving parasitic capacitance **54** and the sensing parasitic capacitance **60** on the mutual capacitance **53** is weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

Preferably, in the embodiment, the number of the vertical metal wires **32** included in the driving electrodes **71** in addition or alternatively the sensing electrodes **72** ranges from 2 to 10, to ensure a valid touch area of the touch layer **204** in the touch liquid crystal display device while reducing the influence of the parasitic capacitance between the vertical metal wires **32** in the touch layer **204** and the vertical driving lines on the mutual capacitance **53**, enhancing the valid signal in the detecting circuit **56**, and increasing the touch sensitivity of the touch liquid crystal display device.

Preferably, in the embodiment of the present invention, the vertical metal wires **32** in the driving electrodes **71** in addition or alternatively the sensing electrodes **72** are evenly arranged, therefore the consistency of sensitivity of each touch point in the touch layer **204** is ensured.

It should be noted that in the embodiment, in order to ensure the aperture opening ratio of the touch liquid crystal display device, the vertical metal wires **32** and the vertical driving lines in the pixel array structure **206** may overlap with each other. However, in order to increase the touch sensitivity of the touch liquid crystal display device, the vertical metal wires **32** and the vertical driving lines in the pixel array structure **206** may be disposed in a stagger manner, therefore, the aperture opening ratio of the touch liquid crystal display device is reduced.

In summary, in the touch liquid crystal display device according to the present embodiment of the present invention, the number of the vertical metal wires **32** in the touch layer **204** is reduced, and the vertical metal wires **32** and the vertical driving lines in the pixel array structure **206** are disposed in a stagger manner, so as to reduce the parasitic capacitance between the source/drain electrode metal layer **42** and the touch layer **204**, and thus increase the touch sensitivity of the touch liquid crystal display device.

Another Embodiment

In order to further increase the touch sensitivity of the touch liquid crystal display device of the embodiment of FIG. **10**, the common electrode layer **43** in the pixel array structure **206** includes multiple horizontally-arranged common electrode lines (Vcom lines) in the touch liquid crystal display device according to the present embodiment as illustrated in FIG. **11**.

Referring to FIG. **10**, in the case where the driving electrodes **71** and the sensing electrodes **72** in the touch layer **204** are disposed in an interleaved way in the row direction, the mutual capacitance **53** between the driving electrodes **71** and the sensing electrodes **72** is generated between adjacent vertically-arranged electrodes. The common electrode layer **43** in the pixel array structure includes multiple horizontally-arranged common electrode lines. Specifically, the common electrodes of each row of pixels are connected together to form a common electrode line, that is, there is no vertical common electrode between the adjacent driving electrodes **71** and sensing electrodes **72** for coupling the driving electrodes **71** to the sensing electrodes **72** to form a parasitic capacitance, therefore, the influence of the parasitic capaci-

tance generated between the touch layer **204** and the common electrode layer **43** on the mutual capacitance **53** generated between the driving electrodes **71** and the sensing electrodes **72** is greatly weakened, and the touch sensitivity of the touch liquid crystal display device is increased.

In summary, the touch liquid crystal display device according to embodiments of the present invention has a simple manufacturing process, a small thickness, a small size and a high touch control sensitivity.

Although the present invention is disclosed by way of preferred embodiments as described above, those embodiments are not intended to limit the present invention. Possible amendments and modifications may be made to the technical solution of the present invention by those skilled in the art by using the methods and the technical contents disclosed above without departing from the spirit and the scope of the present invention. Therefore, any change, equivalent alternation and modification made to the above embodiments according to the technical principle of the present invention without departing from the technical solution of the present invention fall within the scope of protection of the present invention.

What is claimed is:

1. A touch liquid crystal display device, comprising first and second substrates opposite to each other, and a liquid crystal layer disposed between the first and second substrates, wherein, the first substrate comprises:

a touch layer disposed on a surface of the first substrate facing the liquid crystal layer;

an insulating layer disposed on a surface of the touch layer and covering the touch layer; and

a pixel array structure disposed on a surface of the insulating layer facing away from the touch layer,

wherein the touch layer comprises a plurality of driving electrodes and a plurality of sensing electrodes, wherein the driving electrodes and the sensing electrodes are interleaved with each other and insulated from each other,

wherein each of the plurality of driving electrodes and each of the plurality of sensing electrodes comprise a plurality of horizontal metal wires and a plurality of vertical metal wires, wherein the plurality of horizontal metal wires and the plurality of vertical metal wires are interleaved with each other, and wherein each of the driving electrodes comprises a plurality of driving sub-electrodes insulated from each other, or wherein each of the sensing electrodes comprises a plurality of sensing sub-electrodes insulated from each other.

2. The touch liquid crystal display device according to claim **1**, wherein adjacent driving sub-electrodes are electrically connected via a bridge structure; or adjacent sensing sub-electrodes are electrically connected via a bridge structure.

3. The touch liquid crystal display device according to claim **2**, wherein the bridge structure is an interconnect metal in a same layer with a gate electrode metal layer in the pixel array structure, or the bridge structure is an interconnect metal in a same layer as a source/drain electrode metal layer in the pixel array structure.

4. The touch liquid crystal display device according to claim **1**, wherein a common electrode layer in the pixel array structure comprises a plurality of common electrodes that is arranged in a pattern as a pattern of the driving and sensing electrodes in the touch layer.

5. The touch liquid crystal display device according to claim **1**, wherein a number of the vertical metal wires in the touch layer is less than a number of vertical driving lines in the pixel array structure,

in addition or alternatively,
a number of the horizontal metal wires in the touch layer is
less than a number of horizontal driving lines in the pixel
array structure.

6. The touch liquid crystal display device according to
claim 5, wherein the number of the horizontal metal wires
included in at least one of the driving electrodes or the sensing
electrodes ranges from 2 to 10; and the number of the vertical
metal wires included in at least one of the driving electrodes
or the sensing electrodes ranges from 2 to 10.

7. The touch liquid crystal display device according to
claim 5, wherein the horizontal metal wires in at least one of
the driving electrodes or the sensing electrodes are evenly
arranged in the touch layer; and the vertical metal wires in at
least one of the driving electrodes or the sensing electrodes
are evenly arranged.

8. The touch liquid crystal display device according to
claim 5, wherein the vertical metal wires and the vertical
driving lines in the pixel array structure are arranged in a
staggered manner; in addition or alternatively, the horizontal
metal wires and the horizontal driving lines in the pixel array
structure are arranged in a staggered manner.

9. A touch liquid crystal display device, comprising first
and second substrates opposite to each other, and a liquid
crystal layer disposed between the first and second substrates,
wherein, the first substrate comprises:

a touch layer disposed on a surface of the first substrate
facing the liquid crystal layer;

an insulating layer disposed on a surface of the touch layer
and covering the touch layer; and

a pixel array structure disposed on a surface of the insulat-
ing layer facing away from the touch layer,

wherein the touch layer comprises a plurality of block
driving electrodes and a plurality of strip sensing elec-
trodes, the plurality of block driving electrodes and the
plurality of strip sensing electrodes are located in a same
layer, and each of the block driving electrodes and each
of the strip sensing electrodes comprises a plurality of
metal grids formed by a plurality of horizontal metal
wires and a plurality of vertical metal wires interleaved
with each other.

10. The touch liquid crystal display device according to
claim 9, wherein the plurality of block driving electrodes and
the plurality of strip sensing electrodes each are electrically
connected via an external wire.

11. The touch liquid crystal display device according to
claim 10, wherein the driving electrodes and the sensing
electrodes are adjacent to each other and are interleaved with
each other in a column direction.

12. The touch liquid crystal display device according to
claim 11, wherein a common electrode layer in the pixel array
structure comprises a plurality of vertically-arranged com-
mon electrode lines.

13. The touch liquid crystal display device according to
claim 11, wherein the number of the horizontal metal wires in
the touch layer is less than the number of horizontal driving
lines in the pixel array structure, and the number of the hori-
zontal metal wires included in at least one of the driving
electrodes or the sensing electrodes ranges from 2 to 10.

14. The touch liquid crystal display device according to
claim 13, wherein the horizontal metal wires in at least one of
the driving electrodes or the sensing electrodes are evenly
arranged.

15. The touch liquid crystal display device according to
claim 13, wherein the horizontal metal wires and the hori-
zontal driving lines in the pixel array structure are arranged in a
staggered manner.

16. The touch liquid crystal display device according to
claim 10, wherein the driving electrodes and the sensing
electrodes adjacent to each other are staggered in a row direc-
tion.

17. The touch liquid crystal display device according to
claim 16, wherein a common electrode layer in the pixel array
structure comprises a plurality of horizontally-arranged com-
mon electrode lines.

18. The touch liquid crystal display device according to
claim 16, wherein the number of the vertical metal wires in
the touch layer is less than the number of vertical driving lines
in the pixel array structure, and the number of the vertical
metal wires included in at least one of the driving electrodes
or the sensing electrodes ranges from 2 to 10, and the vertical
metal wires in at least one of the driving electrodes or the
sensing electrodes are evenly arranged.

19. The touch liquid crystal display device according to
claim 18, wherein the vertical metal wires and the vertical
driving lines in the pixel array structure are arranged in a
staggered manner.

* * * * *

专利名称(译)	触摸液晶显示装置		
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摘要(译)

一种触摸液晶显示装置，包括彼此相对的第一基板和第二基板，以及设置在第一基板和第二基板之间的液晶层。第一基板包括：触摸层，设置在第一基板的面向液晶层的表面上；绝缘层，设置在触摸层的表面上并覆盖触摸层；以及像素阵列结构，设置在绝缘的表面上背离触摸层的层。触摸层设置在像素阵列结构和第一基板之间。此外，仅需要触摸层的成膜工艺和光刻工艺以及绝缘层的沉积工艺来将非触摸液晶显示装置变换为触摸液晶显示装置。

