Full Screen Optial Fingerprint for LCD based on LTPS Technology

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ABSTRACT

With the development of technology, more and more human recognition technology has been applied in mobile phone recognition. Such as face recognition and fingerprint recognition. Large area or even full-screen fingerprint recognition will be better to achieve confidentiality, such as multi-finger recognition and APP unlock. We have developed 6.7 inch full-screen fingerprint recognition based on LTPS.

1. INTRODUCTION

Nowadays, mobile phones are becoming more and more indispensable to people. The function of mobile phones is no longer just to communicate with others. As more and more mobile phone functions are developed, the requirement for confidentiality will be higher and higher, so more and more body recognition technology is applied in mobile phones. FPR (Fingerprint recognition) has been used in mobile phones as a mainstream identification method. There are more and more studies on fingerprint recognition, such as LCD with Integrated In-cell Fingerprint Sensor [1], Optical Fingerprint Recognition Technology Based on Liquid-Crystal Displays [2] , Organic Optical Sensor Based on a-Si TFT Backplane Used in Fingerprint Identification under OLED Display [3], LTPS TFT-LCD with in-cell optical fingerprint scanner [4].

In view of the research of in-screen fingerprint identification, we have changed from the original passive type, the initial small area and the original multi-chip IC to the current active type, full screen fingerprint recognition and the single-chip highly integrated IC. We have completed the 6.7 " in-cell full screen LCD fingerprint development. The solution of display, touch and fingerprint recognition can be integrated to one IC.

2. TECHNOLOGY

2.1 The key problem of technology

In this paper, we mainly realize full screen optial fingerprint for LCD based on LTPS Technology. There are three main problem to be solved.

First, as figure1 shows, we design the FPR sensor on TFT substrate. In-cell FPR is mainly identified by reflection backlight, Identified by reflection differences between valleys and ridges. It needs to add more wiring and film layers, this reduces backlight penetration. When the backlight reaching the upper surface is reduced, recognition will be poor.

Second, fingerprint scanning time is limited, the time for full-screen fingerprint scanning is insufficient. How to quickly and accurately identify the fingerprint area is one of the difficulties in realizing full-screen fingerprint.

The third, the IC size of TDDI is very large, and the length cannot be increased any more. Therefore, it usually requires two ICs to fulfill the task. One IC is for display and touch, another is for FPR. COF(chip on FPC) design is usually required, this will drive up the cost.

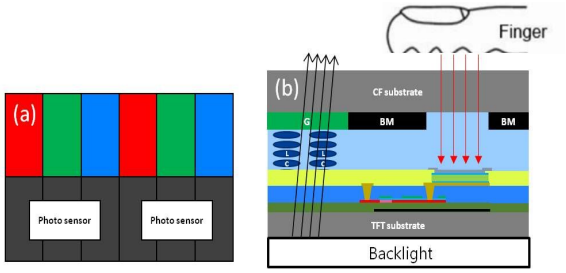

Fig. 1(a) Schematic diagram of FPR Sensor (b) Diagram of FPR light and film

2.2 The technology of full screen optial FPR

2.2.1 Enhanced fingerprint signal

An active pixel sensor circuit based on LTPS photo sensor is design. As shown in figure 2, each APS circuit unit contains 3 LTPS-TFT, 1 LTPS photo sensor for light sensing, 1 storage capacitor for stabilizing the node voltage

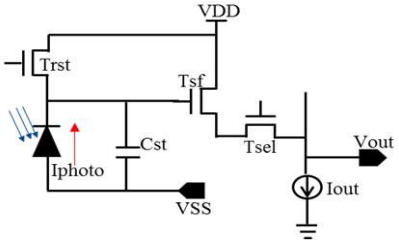

Fig. 2 Equivalent circuit diagram of LTPS active pixel sensor

When the active circuit works, PD (Photo diode)is first charged, PD leakage degree is different under different illumination intensity. According to the formula, Vpd=VDD-I*t/C, Vpd is the voltage of PD, t is the exposure time, Current(I) will be higher when the flux of light goes up. The greater difference in Vpd between valleys and ridges, the fingerprints are more obvious. When the backlight brightness is constant, the I difference between valley and ridge is fixed. When t is larger, the signal difference between valley and ridge will be larger. But t can't be infinitely larger, t have a saturation value, when t is greater than the saturation value, the signal difference between valley and ridge will decrease. As Figure 3 shows, the response curves at different exposure times. To achieve maximum valley and ridge signal differences, t is selected to make the response curve in the linearity near saturation region under different backlights.

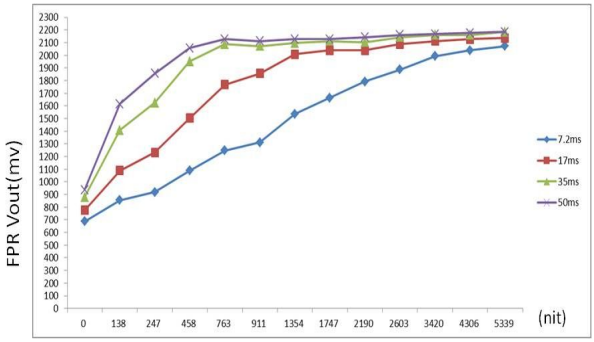

Fig. 3 The response curves of different brightness and exposure time

2.2.2 The block design of full screen optial fingerprint

As figure 4 shows, when a fingerprint match request is received, touch will perform finger press position positioning. Then feedback the XY coordinates to the FPR module, the FPR module will scan the fingerprint partition of the location. Finally, the scanned fingerprint is matched with the original fingerprint.

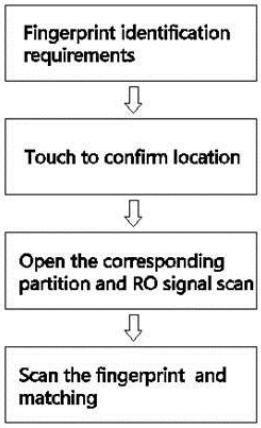

Fig. 4 Fingerprint identification flow

In order to save cost and reduce border, we use one-chip IC, it can integrate display, touch and FPR. As figure 5(a) shows, the RO signal is the output voltage of FPR, a column of signals connected together. As figure 5(b) shows, the source signal is the input voltage of display. We use the same IC output PIN to provide RO signal and source. It usd time-sharing multiplexing technology to realize the integration of display, touch and FPR.

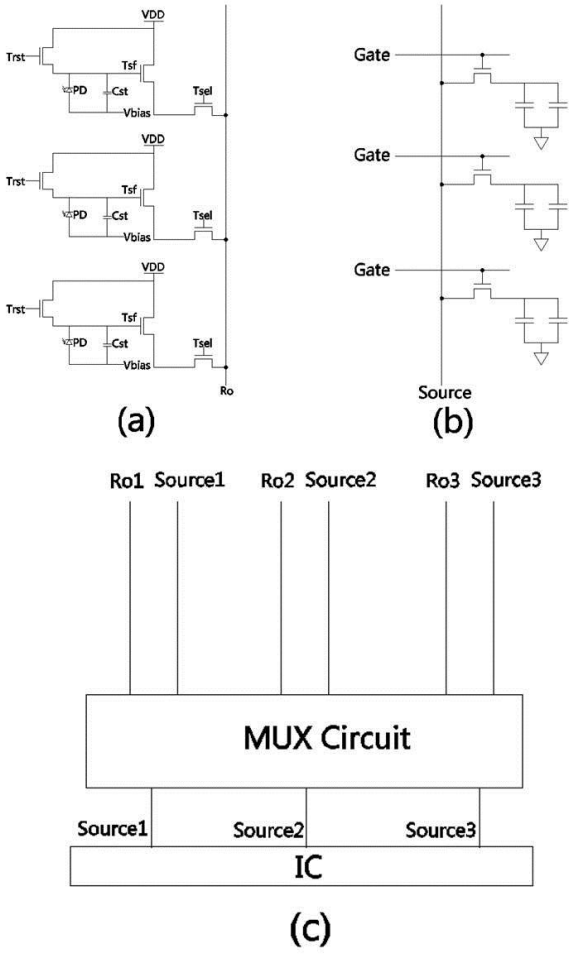

Fig. 5 The Circuit Schematic, (a) Schematic of fingerprint circuit (b) Schematic of display pixel circuit (c) Schematic of RO and Source use in common

As figure 6 shows the horizontal partition design. The more partitions, the less information will be lost, But switching between partitions is a waste of time. Usually, each time open 2~3 partition for scanning is better. Each partition needs one start pluse, only one partition can be scanned at a time. Partition scanning is performed from top to bottom. The second partition is enabled only after the first partition is scanned. Because columns are shared, you need to ensure that only one row of FPR is being scanned at a time.

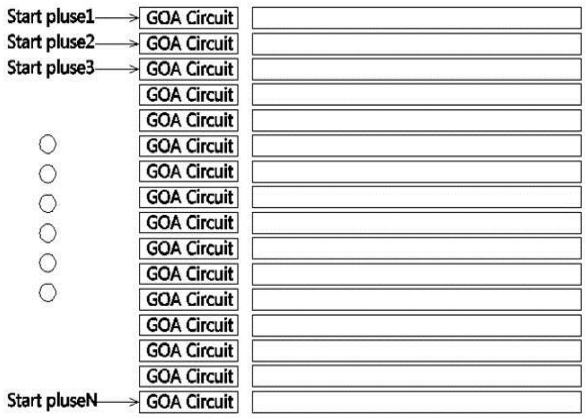

Fig. 6 Transverse zoning diagram

3. RESULT

3.1 Full screen optial fingerprint performance

We have completed the 6.7 " in-cell full screen LCD fingerprint development. COG scheme using a single IC, the thickness is the same as normal TDDI products. Table1 shows the basic information of full screen optial fingerprint display.

Table1. Specification of FPR

Product information	
Item	Data
TFT process	LTPS
Cell process	LCD
Display size	6.7”
Left/right/down border(mm)	0.9/0.9/3.6
Thickness of CG	0.7mm
Resolution	1080RGB×2400
Number of horizontal partitions	20

3.2 Other performance

Fingure7 shows the DEMO with 0.7mm CG. The FRR (False reject rate) is about 0.26% under normal environment. Demo can realize arbitrary position fingerprint reading and multi-finger fingerprint. At the same time, it can also realize fingerprint encryption for the APP.

Fig. 7 (a) The DEMO presentation in figure (b) The amplification figure of fingerprinit

4. CONCLUSIONS

In general, we use one chip IC to achieve full-screen fingerprint for LCD. And it can realize the intergration of FPR, touch and display. The FRR is 0.26% under normal environment. Full-screen fingerprints will greatly improve security and user experience.

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