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Expediting Fingerprint Authentication by Compensating for Display Luminance Latency

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Abstract:

This publication describes systems and techniques directed at expediting fingerprint authentication by compensating for display luminance latency. In aspects, a computing device having a display and an under-display fingerprint sensor (UDFPS), includes a local high brightness mode (LHBM) manager configured to selectively adjust luminance settings in a high-luminance region of the display for predetermined intervals. In so doing, user input can be well-illuminated during an initial stage of UDFPS image capturing, facilitating UDFPS sensing and expediting fingerprint authentication.

Keywords:

Local high brightness mode (LHBM), localized brightness compensation, display panel, active-matrix organic light-emitting diode (AMOLED), display driver integrated circuit, frame rate, pixel array, pixel luminance drop, under-display fingerprint sensor (UDFPS)

Background:

Biometric recognition services provide personalized and convenient methods of user authentication to computing device users. Fingerprint scanning, for example, is a widely used service that enables quick and reliable user authentication, denying or permitting user access to computing devices based on authorized fingerprints. Computing devices offering such services often possess a plurality of on-device sensors. To preserve space on these computing devices, manufacturers may embed these sensors under a display, such as an optical under-display fingerprint sensor (UDFPS). Using an UDFPS, a user may attempt authentication by providing user input (e.g., a fingerprint) to the computing device. For example, a user can place one or more fingers on a display of the device directly above the UDFPS. The device display can illuminate the user input such that an UDFPS can capture reflected light and generate frames ("image capturing") at a predetermined frequency (e.g., frame rate). The frames then undergo signal processing before being evaluated by a fingerprint matching algorithm ("matcher"). For example, the matcher may authenticate the user input based on whether information (e.g., minutia) inferred from the frame matches an enrolled frame of a previously authenticated user.

If, however, user input is sub-optimally illuminated, user authentication may be delayed. For example, in some instances, organic light-emitting diodes (OLEDs) in a display may gradually increase to a target luminance due to a hysteresis effect, providing inadequate illumination of user input during an initial stage of UDFPS image capturing. As a result, matcher evaluation of the user input may be delayed until receipt of later frames, slowing user authentication. Biometric recognition services with slower user authentication speeds are often undesirable to users.

Description:

This publication describes systems and techniques directed at expediting fingerprint authentication by compensating for display luminance latency. In aspects, a computing device having a display and an under-display fingerprint sensor (UDFPS), includes an LHBM manager configured to selectively adjust luminance settings in a high-luminance region for predetermined intervals. Figure 1 illustrates an example computing device in which the described systems and techniques can be implemented.

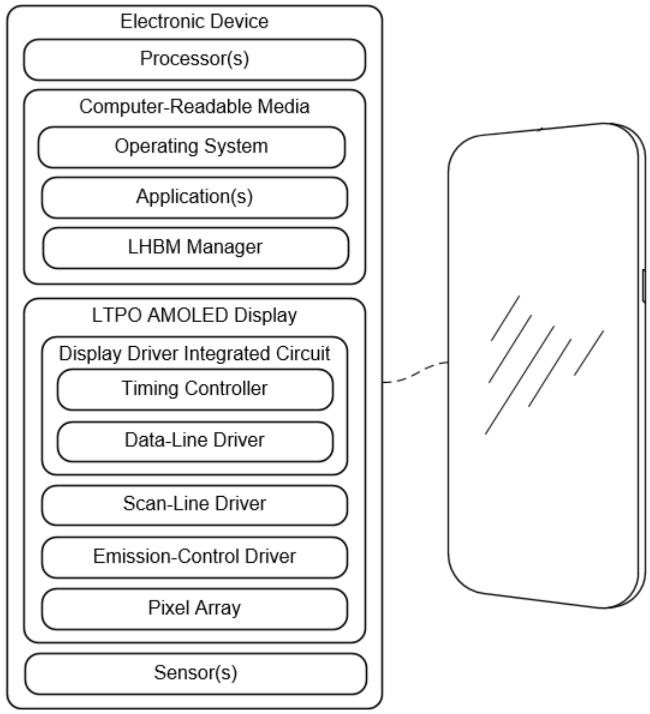

Figure 1

As illustrated in Figure 1, the computing device is a smartphone. In other implementations, the computing device can be a variety of other consumer computing devices. The computing device may include one or more processors. The processor(s) may be configured to execute instructions or commands stored within the computer-readable media to implement an operating system, application(s), and an LHBM manager. For example, the processor(s) can execute instructions of the operating system to implement a biometric recognition system, including fingerprint authentication. Implementing fingerprint authentication may involve processor(s) further executing instructions of a LHBM manager to activate sensor(s), control a display, process signals, and trigger a biometric matching algorithm. The computer-readable media may include one or more non-transitory storage devices suitable for storing electronic instructions.

The computing device may further include a display (e.g., an AMOLED display). The AMOLED display may include display panel circuitry having a display driver integrated circuit (DDIC), drivers, and a pixel array of pixel circuits. The DDIC may include a timing controller and a data-line driver. The timing controller may provide interfacing functionality between the processor(s) and the drivers (e.g., data-line driver, scan-line driver, emission-control driver). For example, the timing controller can accept commands and data from the processor(s) and generate signals with appropriate voltage, current, timing, and demultiplexing. The timing controller can then pass the signals to the drivers. The drivers may be operably coupled to pixel circuits via driver lines.

In a configuration, the computing device may include a DDIC separate from the AMOLED display. In still other configurations, the computing device may include a timing controller separate from the DDIC and the AMOLED display. Additional implementations and components may be configured to control the pixel array and still implement the techniques described herein.

In addition to the above descriptions, the computing device may include one or more sensors. The sensor(s) may be located anywhere in or on the device such as within a housing of the computing device, embedded underneath the AMOLED display, and so forth. The sensor(s) can include one or more of a touch-input sensor (e.g., a touchscreen), an image-capture device (e.g., a camera), a fingerprint sensor (e.g., an ultrasonic fingerprint sensor, an optical fingerprint sensor), a proximity sensor (e.g., capacitive sensors), an ambient light sensor (e.g., a photodetector), and the like.

In an implementation, the computing device includes an UDFPS situated beneath the AMOLED display. Figure 2 illustrates a partial top plan view and a partial, cross-sectional view of the computing device having the UDFPS.

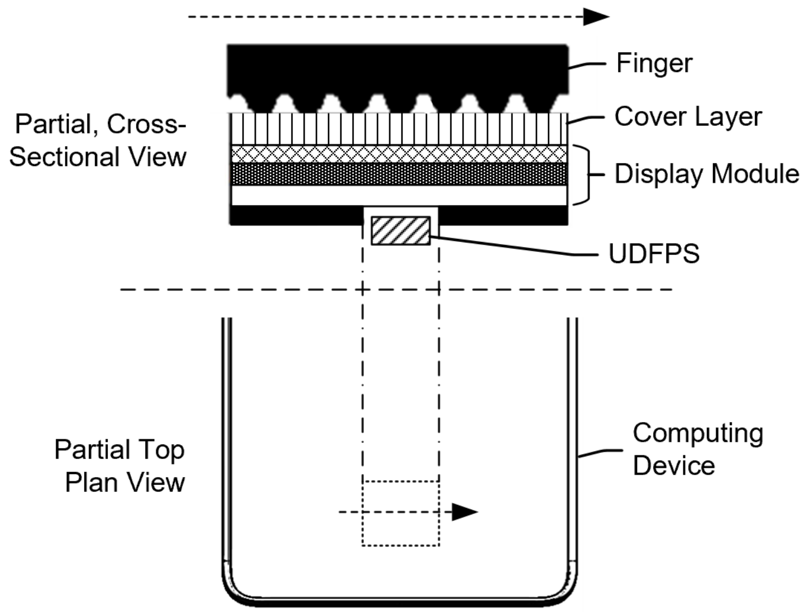

Figure 2

In Figure 2 the AMOLED display has a display panel stack including a cover layer and a display module. In implementations, the cover layer may be any transparent substrate composed of a variety of materials, including plastic or glass. The display module may include one or more of a polarizer film, a display panel, a metallic layer (e.g., a copper layer), optical adhesive (OCA), a clear polyethylene terephthalate (PET) substrate (e.g., a polymer layer), and a back cover. In some implementations, the display panel may be any of a variety of electroluminescent displays including a liquid crystal display (LCD), microLED, and so forth.

The UDFPS may be attached (e.g., bonded, laminated) to the underside of the AMOLED display. The UDFPS is configured to capture reflected light of a user input (e.g., fingers, palm) transmitted through the AMOLED display. Upon capturing the reflected light, the UDFPS can generate a frame containing a visual representation of the user input at a predetermined frequency ("frame rate").

In aspects, during fingerprint authentication, the LHBM manager may activate the UDFPS and instruct the processor(s) to implement a high luminance in a localized region of the AMOLED display ("high-luminance region"). The DDIC, implementing operations of the LHBM manager, can increase the luminosity of individual OLEDs within a high-luminance region. In other implementations, a system-on-chip (SoC) can implement operations of the LHBM manager.

The LHBM manager implementing a high luminance in a localized region may facilitate UDFPS sensing of reflected light from user input. For example, a computing device including an AMOLED display having a visible light transmission (VLT) (e.g., the measurement of light transmission through a medium) of less than 5%, can employ a high luminance in a localized region to intensify the reflected light and facilitate UDFPS sensing. The high-luminance region may define any two-dimensional grid, including a rectangular grid, an elliptical grid, and the like.

Figure 3 illustrates the computing device having a high-luminance region on the AMOLED display.

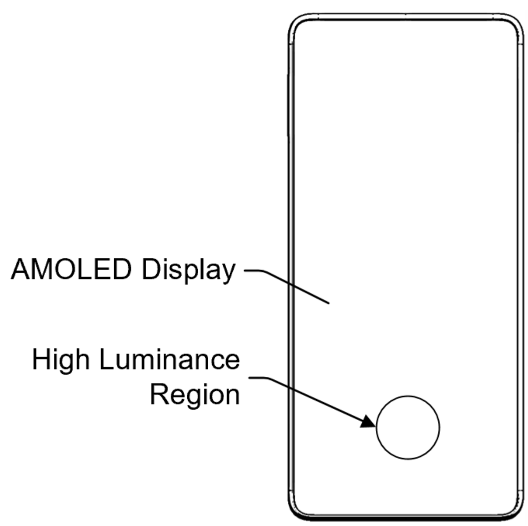

Figure 3

As illustrated, the high-luminance region is localized on a portion of the AMOLED display. The high-luminance region may be located anywhere on the AMOLED display, situated above the UDFPS. Further illustrated, the high-luminance region is implemented as forming a circular grid millimeters (mm) in diameter (e.g., 10 mm). The luminosity of the high-luminance region, expressed in candela per square meter (nit), may be hundreds to thousands of nits greater in luminosity than other portions of the AMOLED display during fingerprint authentication. As a result, during fingerprint authentication, the skin surface of the user input may experience amplified illumination, producing intensified reflected light. The intensification may facilitate reflected light transmission through the display to enhance sensing by the UDFPS. The UDFPS can then generate vivid frames of the user input.

In some situations, during fingerprint authentication, the OLEDs in the high-luminance region experience a response time delay ("latency") when driven by one or more drivers to increase in luminosity. This latency may be due, for example, to a hysteresis effect in transistors of the pixel circuits in the AMOLED display. As a result of the latency, the luminosity of the OLEDs in the high-luminance region may be lower than a target pixel luminance, gradually increasing to the target pixel luminance. This gradual increase in luminosity may coincide with an initial stage of image capturing (e.g., generating a first frame, generating a first couple of frames).

Figure 4 illustrates a graphical representation of display luminance latency in the high-luminance region during fingerprint authentication.

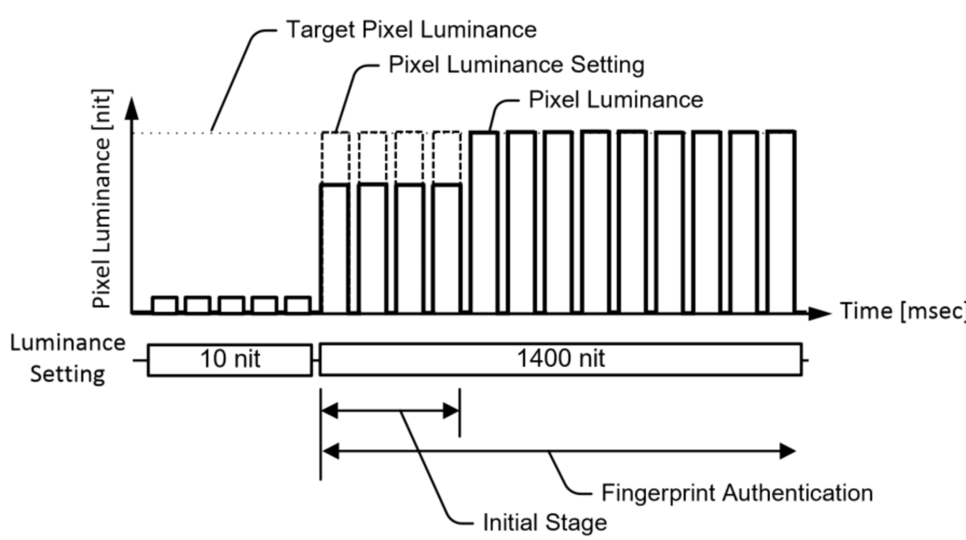

Figure 4

The pixel luminance versus time graph illustrates the pixel luminance of the high-luminance region gradually increasing in luminosity during fingerprint authentication. Figure 4 further illustrates the timing of luminance settings, implemented by the LHBM manager. As an example, prior to fingerprint authentication, the entire AMOLED display may emit light at a luminance of 10 nits. Upon initiation of fingerprint authentication, pixel circuits of the pixel array may receive data-line signals (e.g., voltage data) from the data-line driver operably coupled to the DDIC to implement a luminance of 1400 nits. During an initial stage of fingerprint authentication, OLEDs of the pixel circuits within the high-luminance region may emit light at a luminance of approximately 1000 nits, despite receiving data-line signals targeting a pixel luminance of approximately 1400 nits. After 25 to 50 milliseconds (e.g., a duration of the initial stage), the OLEDs within the high-luminance region may then emit light at a luminance of approximately 1400 nits. This latency in display luminance within the high-luminance region may delay fingerprint authentication operations since user input may be sub-optimally illuminated, driving the UDFPS to generate additional frames.

Figure 5 illustrates a graphical representation of the LHBM manager compensating for display luminance latency in the high-luminance region during fingerprint authentication.

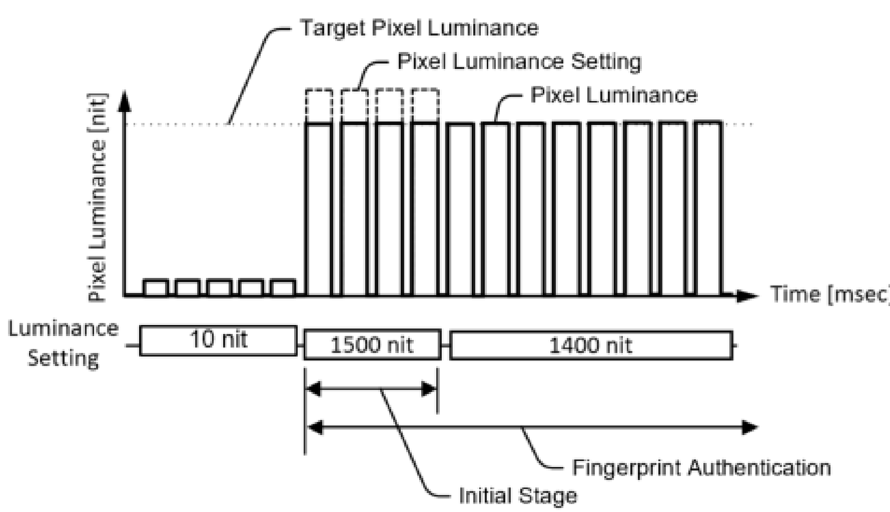

Figure 5

In aspects, during fingerprint authentication, the LHBM manager may compensate for display luminance latency by selectively adjusting the luminance setting in the high-luminance region for predetermined intervals. As illustrated, the LHBM manager may implement a luminance setting targeting a pixel luminance of 1500 nit for an interval (e.g., 25 milliseconds) for which the pixel circuits may be affected by, for example, the hysteresis effect. As a result, the LHBM manager may compensate for display luminance latency by enabling the OLEDs in the high-luminance region to emit light at a desired luminosity of 1400 nit. For a next interval, the LHBM manager may implement a luminance setting targeting a pixel luminance of 1400 nit. Through such a technique, the user input may be well-illuminated during an initial stage of UDFPS image capturing, facilitating UDFPS sensing and expediting fingerprint authentication. In addition, the LHBM manager can implement luminance settings targeting any of a variety of pixel luminance values. For example, the LHBM manager may adjust the luminance settings according to the starting pixel luminance of the high-luminance region prior to fingerprint authentication, as well as according to the overall luminance of the OLEDs in the AMOLED display.

References:

[1] Patent Publication: US20200273427A1. Brightness Control Method and Terminal Device. Priority Date: February 25, 2019.

[2] Patent Publication: US20190228740A1. Display With Localized Brightness Adjustment Capabilities. Priority Date: December 15, 2015.

[3] Patent Publication: CN111241890A. Fingerprint Identification Method, Device, Equipment and Storage Medium. Priority Date: November 29, 2018.

[4] Patent Publication: US20130342519A1. Organic Light Emitting Device. Priority Date: June 22, 2012.

[5] Patent Publication: US20160063933A1. Liquid Crystal Display Device and Driving Method Therefor. Priority Date: April 2, 2013.