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# Dynamic Adjustment of Display Luminance to Reduce Fingerprint Scanner Latency

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ABSTRACT

Optical under display fingerprint scanners (UDFPS) are used for user authentication. The device screen provides illumination to UDFPS when capturing fingerprints through local high brightness mode (LHBM). However, on device screens that suffer from first frame dimming (FFD), this causes latency in reaching the target luminance required to accurately capture the fingerprint. Further, the latency may vary with the initial image being displayed on the screen or other factors such as ambient light, display brightness setting, etc. when the fingerprint authentication process is initiated. This disclosure describes techniques to dynamically apply different levels of compensation to the screen depending on the initial state of the device to compensate for first frame dimming. In the first technique, the actual luminance in the UDFPS region in the initial state is determined and is used to determine the required compensation. Content-dependent compensation is then applied. In the second technique, an image of known luminance is applied between after initiating authentication and before applying the target LHBM luminance. Due to the introduction of a pre-configured fixed value, overexposure and underexposure are automatically avoided.

KEYWORD

- Fingerprint Scanner
- Under display scanner
- UDFPS
- First frame dimming (FFD)
- Fingerprint authentication
- Local high brightness

## BACKGROUND

Optical under display fingerprint scanners (UDFPS) are used to authenticate a user based on matching their fingerprint against a stored signature. The display screen provides illumination when capturing fingerprints through local high brightness mode (LHBM) (of the screen). During fingerprint authentication, displays such as OLED may experience a response time delay when driven by one or more drivers to increase in luminance. This is known as first frame dimming (FFD), or as low first frame rate (FFR).

If the device screen suffers from FFD or low FFR, there is latency in reaching the target LHBM luminance required to accurately capture the fingerprint. The FFD may also vary with the initial image and brightness being displayed on the screen when the fingerprint authentication process is initiated due to which any single point compensation may not provide sufficient luminance for authentication.

## DESCRIPTION

This disclosure describes techniques to dynamically apply different levels of compensation depending on the initial state of the device to compensate for the content dependent FFD. This can be done in two ways. In the first technique, the actual luminance in the local UDFPS region in the initial state is determined. This initial luminance state is used to determine the required compensation for improving FFD. Content-dependent FFD compensation is applied based on these two factors. In the second technique, an image of known luminance is applied between after initiating authentication and before applying the target LHBM luminance. For example, a plain black image (or any other suitable image) can be used. Starting LHBM from a known intermediate state results in applying a fixed FFD compensation for all initial states.


**(a) Low Initial Background Luminance** **(b) Medium Initial Background Luminance** **(c) High Initial Background Luminance**

**Fig. 1: Varying levels of initial background luminance**

Fig. 1 illustrates the problem with varying initial levels of background luminance at the time of initiating fingerprint authentication. Different users may have different backgrounds (e.g., wallpaper or other images) or user interfaces (e.g., when authentication is initiated from within an app such as a payment application, an e-commerce application, etc.) being displayed on the screen when authentication is initiated. The luminance in the fingerprint sensor region may thus vary. For example, a wallpaper with low initial background luminance is shown in Fig. 1(a); an image with medium initial background luminance is shown in Fig. 1(b); and an image with high initial background luminance is shown in Fig. 1(c).

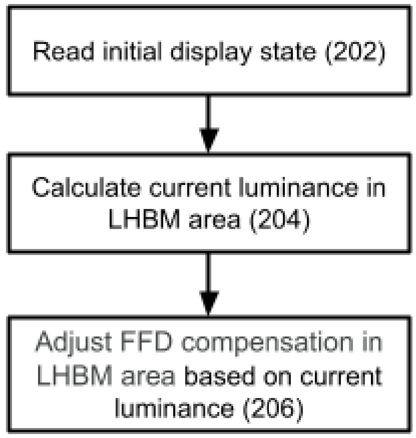
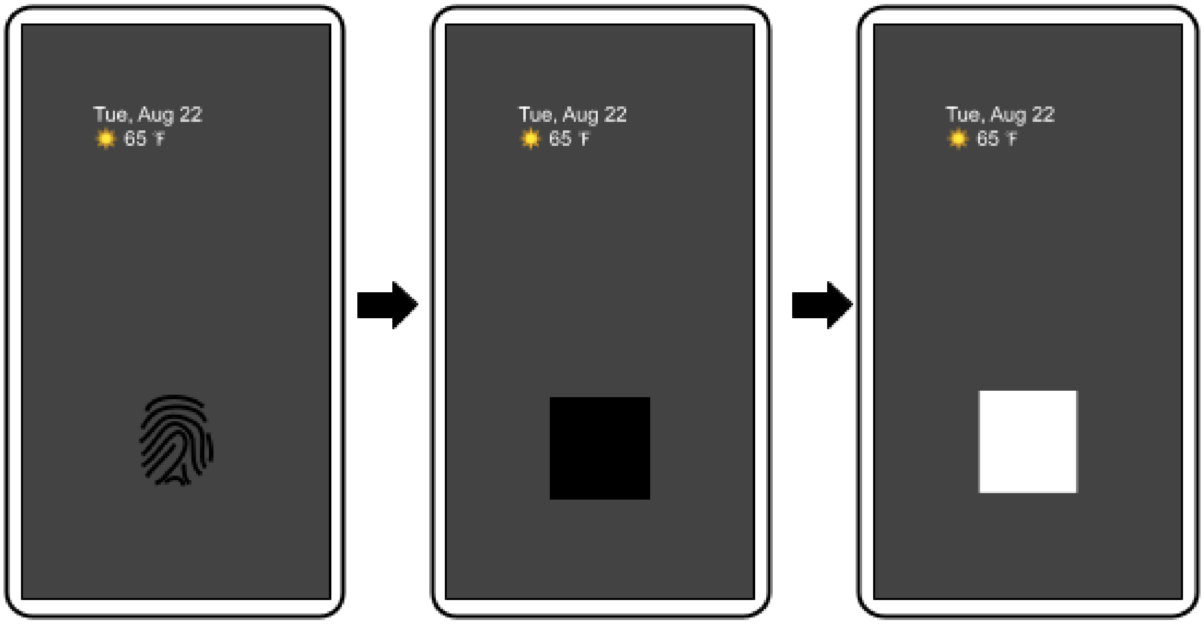



**Fig. 2: Varying levels of initial background luminance**

Fig. 2 illustrates an example method to handle varying levels of initial background luminance in the fingerprint detection area (sensor area) of the screen. The initial display state of the screen is read (202). The current luminance of the LHBM area (sensor area) is calculated (204). The FFD compensation is adjusted towards a target based on the current luminance (206). In calculating the compensation target, the average luminance level or the luminance per-pixel in the specified UDFPS region can be taken into account. For example, the compensation for the region can be based on the average level. Alternatively, the compensation can be performed at a per-pixel level which can provide greater precision and better performance.




(a) Initial display state (b) LHBM area luminance = 0 nits for <1 frame (c) LHBM luminance boosted

**Fig. 3: Applying consistent boost to reduce UDFPS latency**

The final luminance level required for authentication is constant (target LHBM brightness). However, the initial state of the screen can be arbitrary based on what is being displayed on the screen. The initial state can also be different based on other factors such as ambient light conditions, display brightness setting, etc. Applying a single FFD compensation that is not aware of the initial display state can result in over-compensation or under-compensation of the first frame resulting in overexposure or underexposure of the fingerprint.

Fig. 3 illustrates applying a consistent boost to the LHBM area to reduce UDFPS latency. The screen can be in any arbitrary initial display state when authentication is initiated (302). For example, in Fig. 3(a) the device is displaying a wallpaper image with an indication of the area where fingerprint authentication can be initiated. However, when authentication is initiated, the device may be in various states, e.g., displaying an app user interface, with corresponding luminance.

Upon detection of authentication initiation, the LHBM area luminance is set to a pre-configured fixed value, e.g., to display a black image, as shown in Fig. 3(b). In this case, the luminance of the LHBM area, which is the area in which the UDFPS is located, is set to a luminance of zero nits for less than one frame. The LHBM first frame is then boosted to achieve the target luminance and optimize for reducing or eliminating the latency in using the UDFPS, as shown in Fig. 3(c). Due to the introduction of a pre-configured fixed value, overexposure and underexposure are automatically avoided.

## CONCLUSION

This disclosure describes techniques to dynamically apply different levels of compensation to the screen depending on the initial state of the device to compensate for first frame dimming. In the first technique, the actual luminance in the UDFPS region in the initial state is determined and is used to determine the required FFD compensation. Content-dependent compensation is then applied. In the second technique, an image of known luminance is applied between after initiating authentication and before applying the target LHBM luminance. Due to the introduction of a pre-configured fixed value, overexposure and underexposure are automatically avoided.

## REFERENCES

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