January 2020

SYSTEM APPROACH TO COMPENSATE THE BRIGHTNESS NON-UNIFORMITY OF LOCAL DIMMING DISPLAY

HP INC

System approach to compensate the brightness non-uniformity of local dimming display

Abstract

This invention discloses a new system approach to compensate the brightness non-uniformity of local dimming display. An accumulator is in between GPU and display panel to keep accumulating the loading of each zone. When the compensation is triggered, the accumulated loading is feedback to GPU, and then stress the zones with lower accumulated loading to the same level of zones with higher accumulated loading. In the end all the zones have the same accumulated loading.

Background

Local dimming displays is getting attractions in recent years because of better display performance. Examples of local dimming displays including zone level local dimming such as LCD with edge backlight or direct backlight (e.g. mini LED), or pixel level local dimming such as OLED or micro LED. A problem of the local dimming display is the brightness non-uniformity after long time operation. This is because the light sources (e.g. LED or OLED) in each zone are suffering different loading and thus decay differently. In the end the brightness of each zone is different.

A conventional approach to compensate such non-uniformity issue is (1) Build the database of light source (e.g. LED or OLED) decay curve, (2) Record the loading of each zone while panel is on, (3) Estimate the decay of each zone, (4) Compensate each zone to correct brightness by tuning appropriate voltages. However, even with such compensation approach, non-uniformity can still be observed from a real sample. The problem may be originated from step 1, i.e., the database is not always accurate. This is because piece to piece, lot to lot variations. Not every light source (e.g. LED or OLED) follow the same decay curve as the database.

Invention Description

Here we propose a new system approach to compensate the brightness non-uniformity issue. It can also be understood with the diagram in Figure 1.

(1) Tracking:

- Recoding the accumulating the loading history of each zone. (after some time the accumulated loading of each zone would be different and that's why the non-uniformity happens.
- Such recording is done by system. It can be an accumulator between GPU and display panel.

(2) Compensation:

- After specific time (by manual or judged by system), stress each zone to the level of the same accumulated loading.
- The accumulated loading information is feedback from the accumulator back to the GPU.
- The compensation is done when lid is close (to avoid possible visual effect) and power is plugged (to avoid possible power impact).

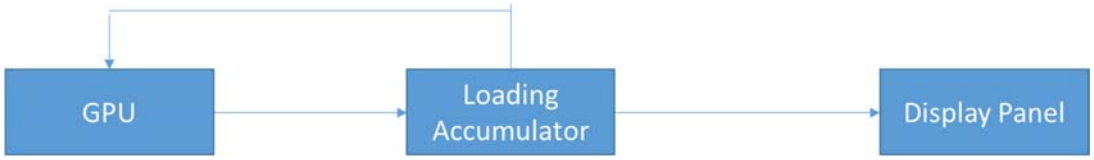

Figure 1. Diagram of tracking and compensation approach.

Advantages

- By accumulate the loading of each zone, we can compensate the luminous difference of each zone by stress all the zones to the same level of loading.
- No light source (e.g. LED or OLED) database is required. Thus eliminate the effects of panel to panel variations.
- No need to apply different voltages to different pixels after compensation. The panel driving is much simplified.
- Compensation can be done manually or automatically (judged by system).
- Compensation can be done when system is idle or when loading variation become too large (judged by system).
- Compensation can be accelerated by applying higher voltage or current, therefore can be quick.
- Suggestion is to run compensation when lid is closed and power is plugged in, thus to avoid visual impact to the user.

Disclosed by Hsing-Hung Hsieh, Leo Yu and Ann Villegas, HP Inc.