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Widening the Spectrum for Monochrome LED Displays with Occasional Voltage Spikes

ABSTRACT

Monochrome LED displays, such as those used for augmented reality (AR) applications, can be unpleasant to view because of the single color used, which is often quite saturated. Approaches to address the issue with the use of phosphors or of LEDs of multiple colors are ineffective or impractical. This disclosure describes techniques to widen the spectrum of colors displayed via monochrome LED displays by occasionally spiking the voltage driving the LED to a higher level. The result is a display appearance that is less saturated and softer.

KEYWORDS

- Monochrome display
- Light Emitting Diode (LED)
- Augmented Reality (AR)
- Smart glasses
- AR glasses
- AR headset
- Color spectrum
- Color saturation

BACKGROUND

Devices such as augmented reality (AR) wearables show information as monochrome images using light emitting diodes (LEDs) of a single color, derived from a single wavelength of light. Although a variety of color choices are available for the single color of the LEDs, all of the colors are extremely saturated. As a result, in some cases, the monochrome appearance of the information can be unpleasant.

The issue can be addressed by using a phosphor to convert part of the light from the color of the LED to one of a longer wavelength. For example, an orange phosphor can be combined with a blue LED to produce light that is approximately white. However, such an approach does not work in situations where narrowband light is required by specific components or when light emission is spatially structured at a small scale.

Another potential approach is using LEDs of multiple colors. However, such an approach may be impractical due to the increase in the display complexity, weight, and cost.

DESCRIPTION

This disclosure describes techniques to widen the spectrum of colors displayed via monochrome LED displays, such as displays used in AR glasses or headsets. The spectrum-widening is achieved by occasionally spiking the voltage driving an LED to a higher level.

Since the wavelength of light produced by an LED is a function of the applied voltage, varying the voltage results in varying the color as well as the intensity of the emitted light. As a result, when an LED is operated at a nominal lower voltage for a majority of time and spiked to a higher voltage on occasion, the output appears as a mix between the two colors - the colors at the lower and the higher voltage, respectively. Moreover, the appearance of the display is less saturated and softer. By appropriately controlling the duty cycle of the occasional higher voltage spike, the LED can be made to appear as emitting the average of the colors at the lower and higher voltages, respectively.

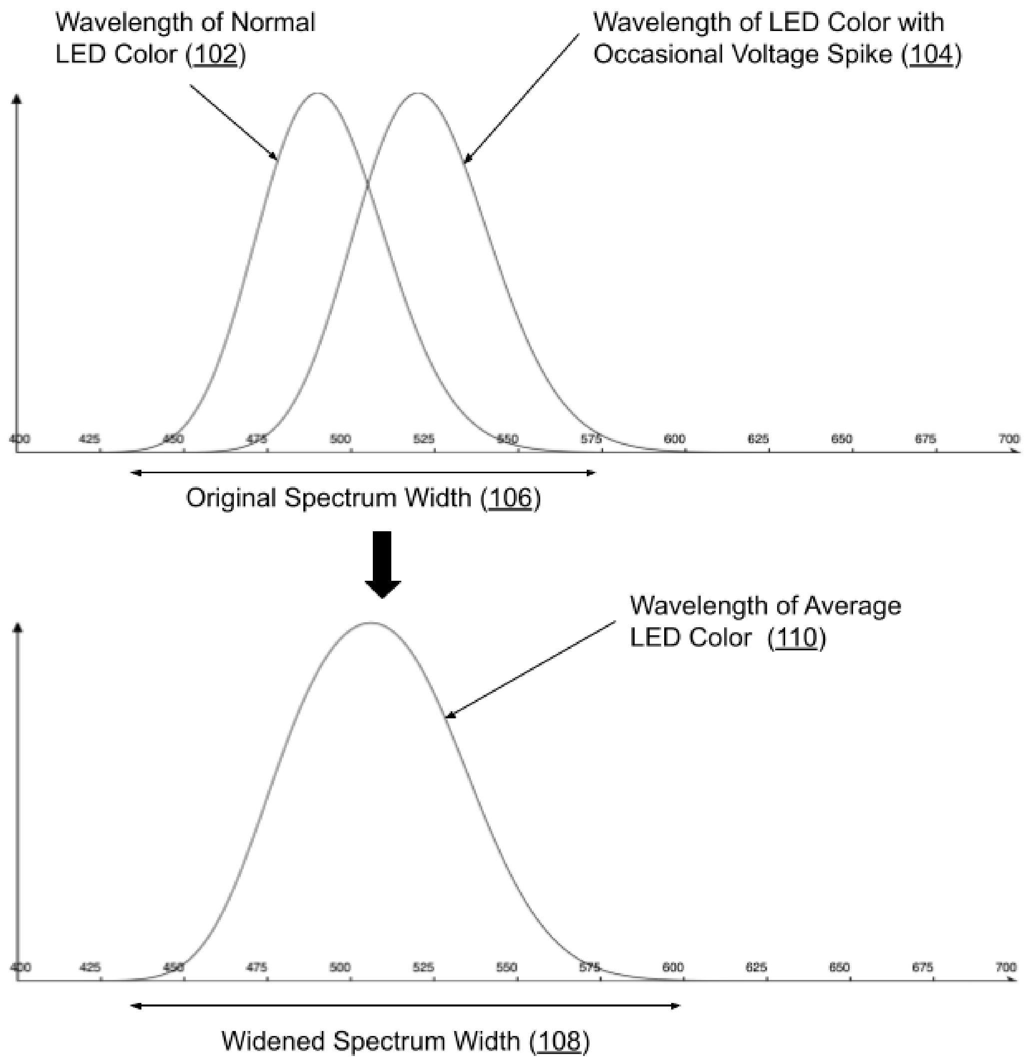

Fig. 1: Occasionally spiking LED voltage to achieve a wider color spectrum

Fig. 1 shows a depiction of the operational aspects of the techniques described in this disclosure. The waveform on the left at the top of Fig. 1 represents the original spectrum width (106) as determined by the wavelength of the normal color of the LED (102) at the typical lower operating voltage. A spike to a higher voltage changes the emitted color, thus shifting the spectrum of the emitted color (104) to the right. The appearance of the LED is the average of the two colors (110) as depicted in the bottom waveform in Fig. 1. The average color provides a spectrum that is wider (108) than the original.

If the LED were to be operated continuously at the higher voltage, the resulting higher current can damage the LED or shorten its operating life span. However, the occasional nature of the voltage spikes necessary to achieve the functionality described above ensures that widening the spectrum using the described approach ensures that there is little to no adverse impact on the LEDs within the display. The timing and duration of the occasional spikes and the specific LEDs within the display to which the spike is applied can be determined during operation based on the specific information or image to be displayed on the screen.

The described techniques can be incorporated within any device that employs a monochrome LED display. Implementation of the techniques widens the spectrum of light that can be shown, thus making it possible to show colors that are less saturated and softer, and thereby enhancing the user experience (UX) of viewing information via such displays.

CONCLUSION

This disclosure describes techniques to widen the spectrum of colors displayed via monochrome LED displays by occasionally spiking the voltage driving an LED to a higher level. By appropriately controlling the duty cycle, the LED can be made to appear as emitting the average of the colors at the lower and higher voltages. The result is a display appearance that is less saturated and softer. The occasional nature of the voltage spikes necessary to achieve the functionality described herein ensures that widening the spectrum in this manner results in little to no adverse impact on the LEDs. The techniques can be incorporated to widen the spectrum within any device that employs a monochrome LED display.

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