Online OLED Dynamic Voltage Scaling for Video Streaming Applications on Mobile Devices

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ABSTRACT

This work proposes an online DVS approach for OLED-based mobile video applications to reduce display power consumption. A time-efficient representative-region based DVS scheme is developed and applied in MPEG video streaming. Based on the proposed scheme, flexible DVS solutions can be adaptively derived according to timing constraints. Experimental results show a 26.9% power reduction while keeping 99.3% frames displayed in high quality.

1. PROBLEM ANALYSIS

As a basic component of mobile devices, display panel dominates the total power consumption. OLED (Organic Light Emitting Diode) is believed to be the replacement of LCD (Liquid Crystal Display) in mobile device displays due to the improved power efficiency and stable display quality. Different from LCD, OLED has color-dependent power consumption and self-illuminating feature, thus no backlight is needed. Due to the inherent differences, previously proposed LCD DVS (Dynamic Voltage Scaling) approaches are not effective for OLED. Researches of OLED DVS strategies are consequently explored. For power-efficient display, static images can be divided into partitions, and local voltage levels are adjusted accordingly for each partition [2][4]. An offline DVS solution for video sequences is proposed recently [3]. However, it is computation intensive and not applicable for online video streaming. For real-time processing, the procedures of downloading, decoding, processing and displaying cooperate with each other and share the time intervals between adjacent frames during the video streaming. In this work, we propose an online OLED DVS scheme for video streaming applications on mobile devices, to minimize the display power consumption.

2. METHODOLOGY

For MPEG video sequences, the proposed approach identifies frame types and applies corresponding processing strategies accordingly. For an I frame, which is the first frame in one GOP (Group of Pictures) and the reference of the following B or P frames, DVS decisions are made after it is completely decoded because of its intra compression encoding nature. For the following P and B-frames, the voltage levels of the reference frames are either directly applied to P and B frames in this GOP, or modified to fit to the difference. To cope with timing constraints and leverage OLED color-dependent power consumption character, in this paper, the DVS is done only for selected representative regions. Representative regions are defined as those with large potential to achieve high power saving and small quality loss. Display quality is evaluated by SSIM (structural similarity index). The processing strategy is determined by the frame type (I, or non-I), then the number of representative regions is decided by the local deadline. Among the regions previously divided from one frame, corresponding representative regions are selected based on color-dependent power consumption and the SSIM quality. Only the selected representative regions are processed for voltage scaling so as to meet the timing constraints. Consequently, flexible online DVS solutions can be generated by the proposed technique.

3. SIMULATION RESULTS

We tentatively evaluate the effectiveness of the proposed OLED DVS technique with four different types of video streams, all of which have the resolution of 640×360 and refresh rate of 30fps. The offline optimal technique presented in [3] is used in the experiments as comparison reference.

Table 1: Display power saving.

testbench	offline[3](%)	online(%)	online/offline(%)
News	36.7	15.7	43.1
Cartoon	35.2	17.9	50.7
Game	46.9	37.6	80.1
Movie	45.6	36.8	80.7
Average	41.1	**26.9**	65.7

Table 2: Display quality: SSIM distribution.

	offline[3]	proposed online	
Quality (SSIM)	High (0.98-1)	High (0.98-1)	Medium (0.96-0.98)
News	100%	100%	-
Cartoon	100%	100%	-
Game	100%	97.3%	2.7%
Movie	100%	100%	-
Average	100%	**99.3**%	0.7%

The conclusions are:

- Compared with displays without DVS, the proposed online DVS attains 26.9% power saving, which is 65.7% of the saving from the offline solution (Table 1).
- The offline method keeps all frames in high quality (SSIM≥0.98), while the proposed online DVS delivers 99.3% high quality frames during displays (Table 2).
- Based on the instruction throughput and power model of mainstream mobile GPUs [1], the computation overhead is analyzed to be 1.37% of GPU's computation capacity. The proposed online DVS technique consumes only 0.05% of the screen power we have saved.

4. REFERENCES

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