Live Demonstration: Real-Time High Dynamic Range Video Acquisition using In-pixel Adaptive Content-Aware Tone Mapping Compression

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***Abstract*—This demonstration targets the acquisition of real-time video sequences involving High Dynamic Range (HDR) scenes. Adaptation to different illumination conditions while preserving contrast is achieved by using a sensor chip, which implements an adaptive content-aware tone mapping compression algorithm by using in-pixel circuitry. Its response gets adapted to changing illumination conditions by using at each frame a statistical estimation of the light distribution, which is derived from the HDR histogram calculated at the previous frame. This method allows adaptive HDR video, while capable to capture very large DR scenes including moving objects.**

Track selection—11.1 Imagers and Vision Processing.

I. Introduction

Tone Mapping algorithms are extensively employed to compress High Dynamic Range (HDR) scenes into Low Dynamic Range (LDR) representations, while maximizing contrast and details. This renders them appealing for hardware implementation where power, speed and cost considerations call for using the smaller possible number of bits to encode sensor data. However, conventional tone mapping algorithms involve intensive computation per every tone mapped frame. Multiple exposures are typically used; i.e. for every HDR frame a set of LDR frames with different expositions must be obtained, stored and combined. All-in-all, this requires large computation resources, fast memories and large bandwidth. Furthermore, unavoidable delays between LDR frame acquisitions produce ghosting artifact in the presence of moving objects, whose reduction calls for large post-processing computation. The larger the required DR, the larger the amount of LDR frames required, and so the larger the mentioned required resources. Actually, conventional tone mapping video systems employ typically three frames at most, thus being unable to acquire HDR video scenes including simultaneously light sources (large DR) and moving objects (ghosting). The sensor employed at the front-end in this demo implements the compression operation using fully-parallel in-pixel circuitry. Thus, the tone mapped final frame is directly retrieved from the chip (single shot), with very little computation off-chip required.

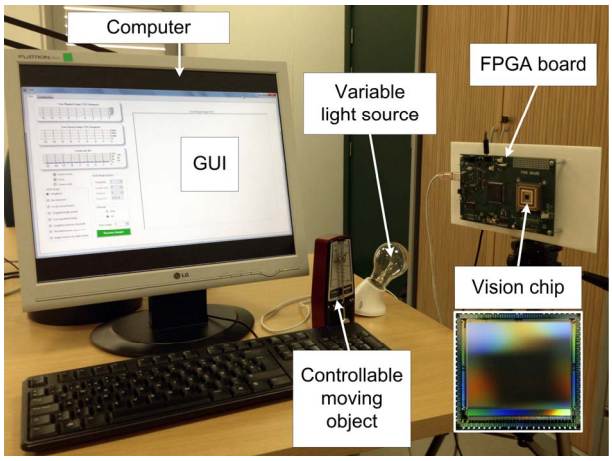

Fig. 1. Demo system setup.

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II. Demonstration Setup

The equipment of the demo system (Fig.1) includes: i) a laptop PC; ii) a custom made FPGA board with the vision chip [1] inserted; iii) a variable source of light and a controllable moving object. The FPGA provides the chip control signals, while receiving the HDR histogram and video frames. Additionally, it accumulates the HDR histogram provided by the chip and compute video light adaptation. The video frames are sent to a PC through a USB link. Finally, a C++/CLI Graphic User Interface (GUI) shows the video.

III. Visitor Experience

During the demo, visitors can vary the illumination conditions. They can also interact with the sensors by producing their own images; for instance, placing a hand in front of the vision chip and make movements. The GUI on the computer will show the HDR tone mapped video of the scenes in several HDR details amplification modes, depending on visitor choice.

References

[1] Vargas-Sierra, S.; Linan-Cembrano, G.; Rodriguez-Vazquez, A., "A 151dB High Dynamic Range CMOS Image Sensor Chip Architecture with Tone Mapping Compression Embedded in-Pixel," Sensors Journal, IEEE, doi: 10.1109/JSEN.2014.2340875G, URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6860247&isnumber=4427201, in press.