Efficient, High Brightness, High Dynamic Range Projection

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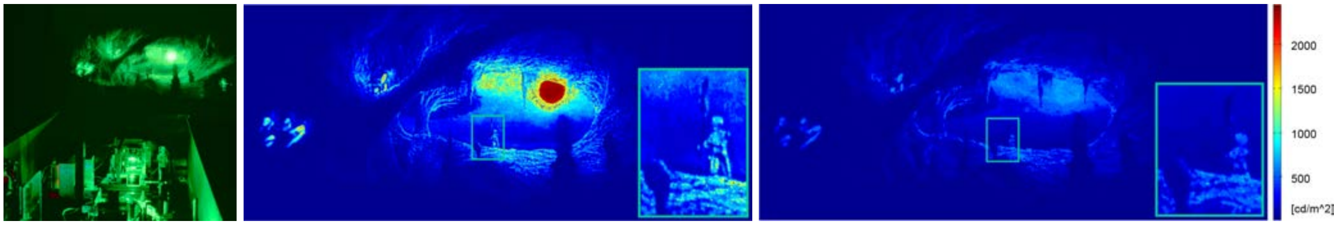

Figure 1: *Effect of light re-direction principle: steering instead of blocking of light within a projection system.* ***Left:*** *Prototype of the monochromatic 532nm, high peak luminance, HDR projector (foreground) and HDR image on screen (background).* ***Center:*** *Our results: luminance measurement of the projected HDR image.* ***Right:*** *Traditional (light attenuating) projector for comparison using the same laser light source. For useful visual comparison the image has been tone mapped (brightened) to account for the peak luminance and contrast capabilities of the traditional projector.*

1 Introduction

Projection is a popular form of imaging but suffers from dim peak light levels and poor contrast, limiting effective use to dark and controlled viewing environments like the cinema (Figure 1). We introduce a novel High Dynamic Range (HDR) projection technique that achieves both dark black levels and very bright peak luminance in an energy and cost efficient implementation.

2 Technical Approach and Results

To reproduce HDR content, the average picture level (APL) must be appropriate for the viewer's environment-dependent light adaptation level (e.g. bright for outdoor displays, dim for cinema)[Reinhard et al. 2012]. HDR is then defined as a large range of displayable luminance values above and below this adaptation level, typically several orders of magnitude wide.

From a hardware point-of-view making bright HDR projection systems is quite difficult. The most significant challenge of traditional projectors is that meaningful gains in brightness require exponentially more powerful light sources to account for the human visual system's near logarithmic brightness perception of light.

As such, recent techniques try to increase the dynamic range by improving black level, but not peak luminance. Some examples include dimmable light sources (lamps, LED, lasers), global dynamic irises, better contrast spatial light modulators (SLM) or cascaded stages of light blocking SLMs [Damberg et al. 2007]. Light re-allocation and recycling methods have also been proposed, but given their prototype stage results, are somewhat impractical for high quality image projection [Hoskinson et al. 2010].

Our system efficiently steers light away from dark areas and into parts of the image that require more light in order to achieve very high peak luminance and good black levels in an overall efficient projector. We have developed a suite of novel algorithms in the field of computational display to control off-the-shelf dynamic optical modulators within our system architecture. Please visit our demonstration and talk at the Emerging Technologies section at Siggraph 2014 to learn more.

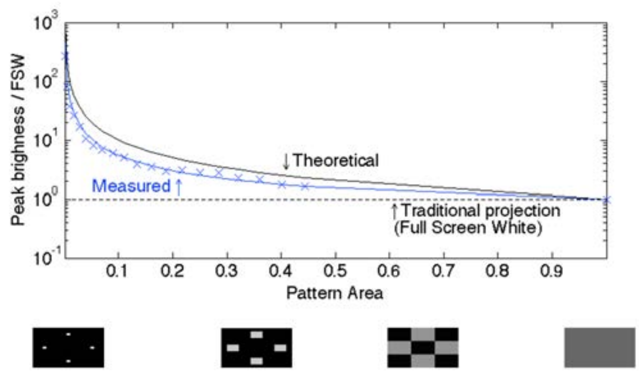

Figure 2: *Light steering capability of the prototype showing increased dynamic range for test patterns with fixed APL. All data is normalized to the full screen white (FSW) feature on the right. Theoretical values assume perfect light redirection.*

References

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SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

ACM 978-1-4503-2961-3/14/08