Capturing and grouping SDR frames from a video to reconstruct HDR

Author: Rinke Schreuder
Supervisors: R. Wiersma & E. Eisemann

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r.r.schreuder@student.tudelft.nl

Background

This research is based on a film-making technique used in The Mandalorian[1]

Displaying a High Dynamic Range (**HDR**) image on a Standard Dynamic Range (**SDR**) screen results in a loss of detail when capturing this screen with a camera.

The HDR frames must be displayed in SDR segments, called **illumination maps** *(Fig. 1)*.

Research

The research goal is: Artificially expanding the dynamic range of an SDR screen.

The focus lies on capturing segments of the dynamic range and finding a good sequence and method to merge those back to form the original image.

Method

The pipeline consists of displaying, capturing, selecting and merging

Displaying and capturing *(Fig. 2)*:
- Illumination maps are displayed at a set rate (20/40/60 fps).
- The camera will capture the screen at a constant rate (60 fps)

Selecting and merging key frames:
- Captured frames are grouped by their illumination map, based on the **image difference** [2].
- Image with minimum difference of each subset is selected as a key frame *(Fig. 3)*
- Additive merging of compatible frames

Results

The program is able to process the captured frames to form the expected output. This works for different display rates. Downside: The current implementation discards frames

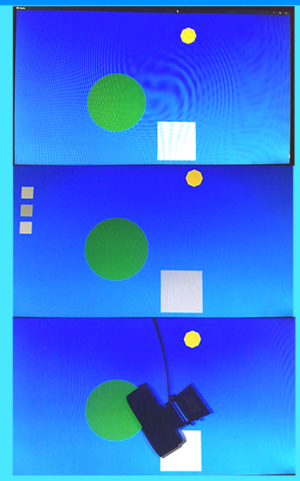

Fig. 5, 6, 7 Reconstructed images.
Fig. 6 uses separate ROIs.
Fig. 7 has an object in front of the screen

Conclusion

The proposed method is a good starting point for tackling the problem of artificially extending the dynamic range. The program works, but has flaws that limit its usefulness.

Fig. 1 Illumination maps with different exposures.

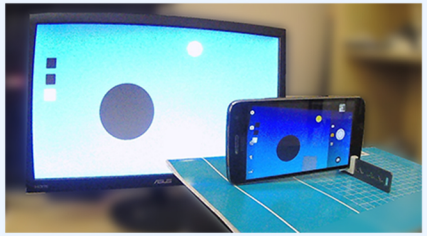

Fig. 2 Frames are displayed in sequence while a camera captures the monitor

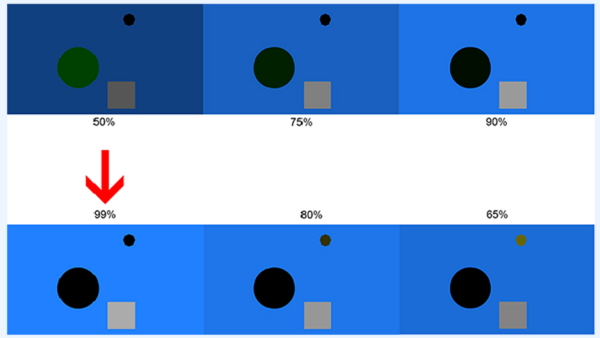

Fig. 3 Selection of the key frame in a subset.

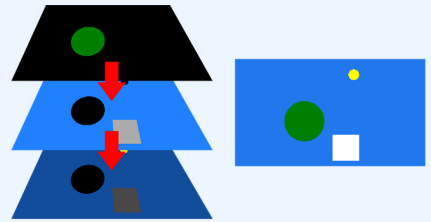

Fig. 4 Merge result of the monitor

[1] Devin Coldewey. The Mandalorian: This is the way.https://techcrunch.com/2020/02/20/how-the-mandalorian-and-ilm-invisibly-reinvented-film-and-tv-production/,2020.
[2] Irena Koprinska and Sergio Carrato. Temporal video segmentation: A survey. Signal processing: Image communication, 16(5):477–500, 2001.