Adding Bloom to High-Dynamic-Range Tone Mapping

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Introduction

To create images with details in both dark and light areas, tone mapping can be used.

In **tone mapped images**, such as (a) in the figure below, bright areas **might not seem very bright**.

One way to make bright areas seem more bright is by adding a **glowing effect**. This is based on the fact that camera lenses and the human eye diffract (bright) light in a disk pattern.

One way to add these glowing effects is the **bloom shader effect**, an effect often used in video games.

We use a modern form of bloom called **"convolution bloom"** to make the effect more realistic and versatile than other bloom methods.

We also present multiple **parameters** to add creative control over the final result.

(a) A tone mapped image. (b) Images generated by our algorithm.

Figure 1. An original tone mapped image compared to the same image enhanced by our algorithm.

Method

The method is as follows:

1. As input, we take a set of **images with different exposure rates**.
2. We create a **tone mapped** image using Mertens' Exposure Fusion.
3. We take the image with the **lowest exposure value**. This image will be used to create the bloom overlay.
4. We apply the **smoothing factor**, highlighting the brightest areas.
5. We **convolve** the smoothed image with a given **kernel**.
6. We **merge** the tone mapped image with the bloom overlay.

We also present multiple parameters:

- First of all, the **kernel** used has a big impact on the result.
- The size of the kernel also determines the **spread**.
- The **smoothing factor** allows the user to determine how bright an area has to be to give off a significant amount of glow.
- The **bloom intensity** determines how intense the bloom will be after it's applied.

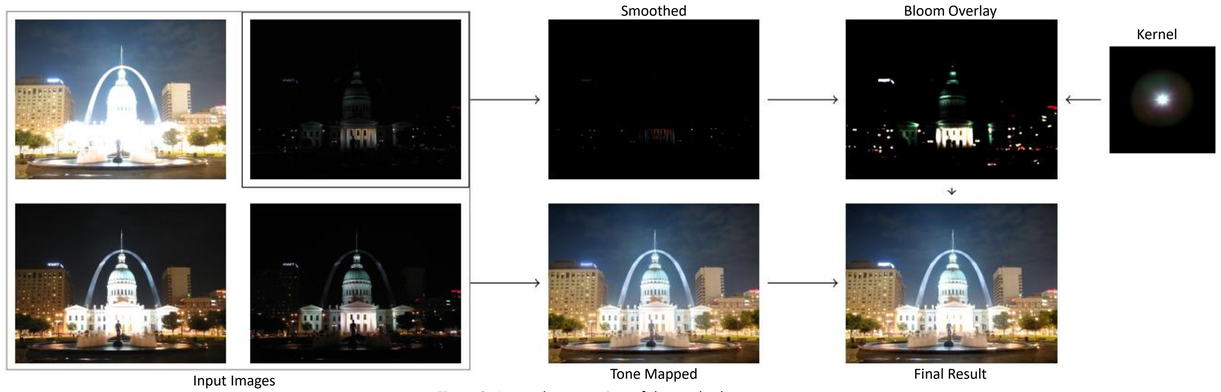

Figure 2. A complete overview of the method.

Conclusion

The presented technique works for different kinds of images.

It can make certain areas more **overwhelming**, or make bright **highlights pop**.

Using a different kernel can greatly impact the result.

The **parameters** add additional creative control, allowing the photographer to determine how bright an area should be for bloom to be applied, and how intense the bloom will be.

Future Work

In the future, the algorithm could be improved in the following ways:

- When the smoothing factor is too low, the image becomes unappealing. Determining a decent minimum smoothing factor automatically would make the process easier.
- Certain areas could manually be selected, both for adding and removing bloom.
- Research could be done into what kernels work well for bloom, both for this method and e.g. video games.

References

Figure 2: Original images by Kevin McCoy, kernel by Epic Games Inc.

Figure 4: Original images by Daniel Pîrcălăboiu

Tone mapping: T. Mertens, J. Kautz, and F. Van Reeth, "Exposure Fusion," in 15th Pacific Conference on Computer Graphics and Applications (PG'07), Oct. 2007, pp. 382–390,iSSN: 1550-4085

Convolution bloom: Epic Games, Inc., "Unreal Engine - Image-Based (FFT)Convolution for Bloom," 2017.

Results

Figure 3. A mountain scene enhanced with bloom.

Figure 4. An image with small highlights.

Figure 5. A close-up of a light source.

Figure 6. An image using a red-tinted kernel. See Fig 2 for the tone mapped image.