Supplementary Material: Examining Autoexposure for Challenging Scenes

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Our supplementary material includes additional AE algorithm implementation details and dataset visualizations.

1. AE algorithms

The main paper discussed four AE algorithms. Here we discuss the settings for these algorithms. In particular, we provide details on the global, semantic, and saliency AE algorithms. These methods use the same AE mechanism of adjusting the shutter speed based on histogram means and its relationship to a target value (key). These methods differ in how they construct (or manipulate) the image histogram. This is followed by a discussion on the entropy AE method that uses a different strategy to decide the optimal AE value.

Histogram manipulation AE Recall that a histogram H is represented by a combination of its pixel values H_p and corresponding weights H_w.

- Global AE gives all pixels within the image an equal weight.
- Semantic AE uses the hand-drawn bounding boxes provided for each frame within a scene. All pixels within the bounding boxes are given a weight of 1; pixels outside the bounding boxes are given a weight of 0.
- Saliency AE uses the last time step's saliency map to generate weights for the current time step's histogram. To generate the salient map, we use the fast saliency detector [4] on the sRGB image produced by the prior time step. This produces a saliency map where each pixel has an associated value between 0 and 1. Next, we build a binary saliency map where any pixels above γ are considered salient; γ can be interpreted as the "sensitivity" of the saliency detector. Salient pixels were given a weight of β, and the remaining pixels were given a weight of 1. For our implementation, we set $\gamma = 0.1$ and $\beta = 14$. Figure 1 contains two examples of our generated binary saliency maps. Additionally, for the first time step in a scene, we consider no pixels to be salient.

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After using the algorithm-specific weighting function, all algorithms implemented a histogram clipping of saturated pixels. This was done by zeroing the weights of all pixels with an intensity greater than 90% of the maximum intensity value in the image.

Entropy AE For entropy AE, the frame with the maximum entropy within sRGB space is chosen for each time step. Our implementation of entropy AE is advantaged because a typical implementation has to perform a local search to find the maximum entropy image [3, 2, 1], however, in our case, we search the entire exposure stack to find the optimal entropy image.

2. Platform GUI

In addition to the basic function introduced in the paper, our platform allows visual exploration of the dataset and AE algorithms. Sliders allow navigation of the exposure and temporal dimensions. For example, Figure 2A shows the 16th image (shutter speed 2/5 s) of the 36th frame in scene 1 of our dataset. This image can be selected manually with the sliders or by an AE algorithm. Our platform displays three plots that help the user understand the AE algorithm's performance: the RAW image histogram, the processed image (sRGB) histogram, and the current frame stack mean values. The user may pause the algorithm at any frame and adjust the vertical slider (to visualize an image with another EV from the same frame); in this mode, the user is shown the difference between the current image and the one selected by the AE algorithm in terms of the RAW histogram and mean (visualized in Figure 2B).

3. User study videos

Videos produced by our platform GUI for all 4 AE algorithms on different scenes are available on our project page. Additionally, Figures 3-5 show time plots comparing the AE algorithms on scenes 1, 3, and 7.

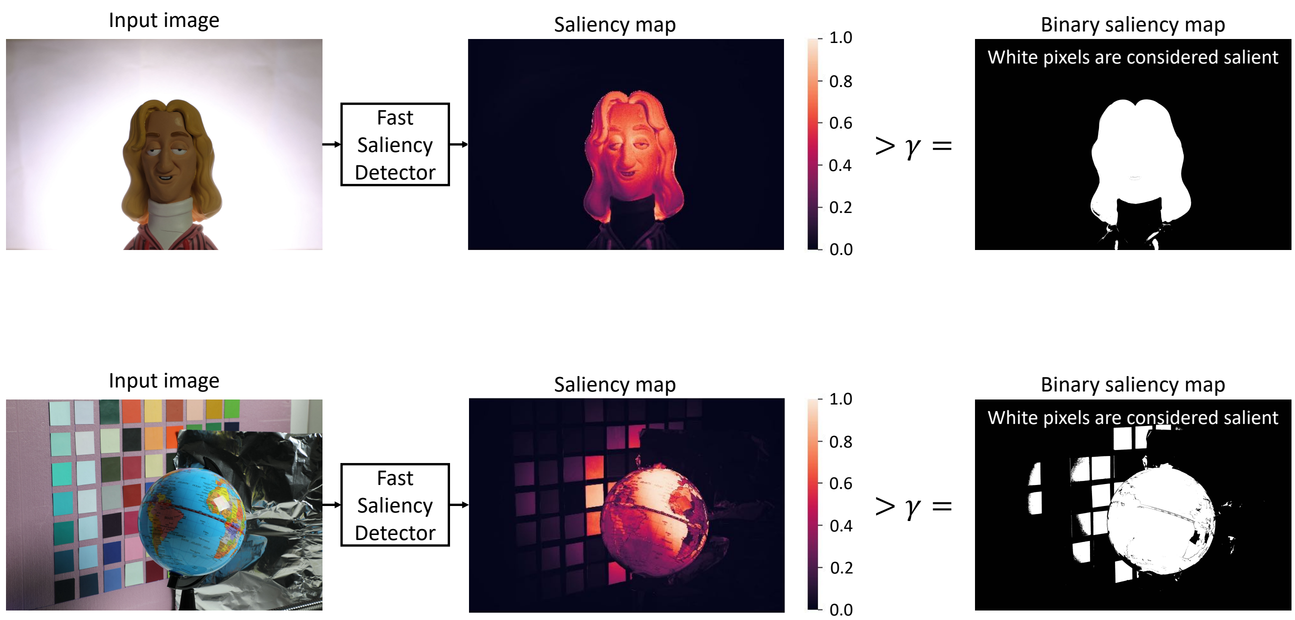

Figure 1: Example binary saliency maps generated from two images in our dataset. Each binary saliency map is generated by a fast saliency method [4] thresholded with $\gamma = 0.1$.

4. Dataset

Figures 6-15 show examples of different scenes from our dataset; for each scene, we split the exposure stack across two figures.

Figure 2: A visualization of our AE platform. When an AE algorithm runs (A), the platform displays the output images and the corresponding plots including "RAW histogram", "sRGB histogram" and "Exposure vs RAW histogram mean". The user is able to "pause" at any time frame to adjust the exposure stack slider for comparison (B). The plots of "user selected RAW histogram" and "AE algorithm RAW histogram" as well as their "RAW histogram mean" are also shown for contrast.

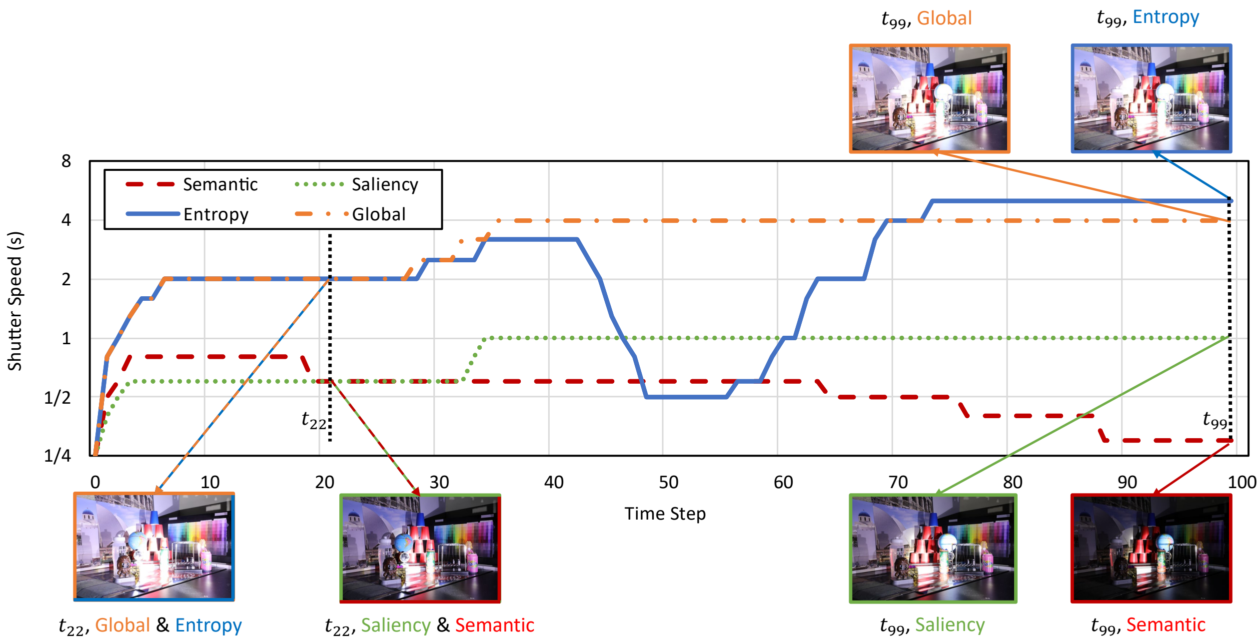

Figure 3: Scene 1 time plot visualizing how AE algorithms choose different exposures at various time steps. This scene contains a moving mirror (high reflective object). Additionally, we visualize the images chosen by the AE algorithms at time steps 22 and 99.

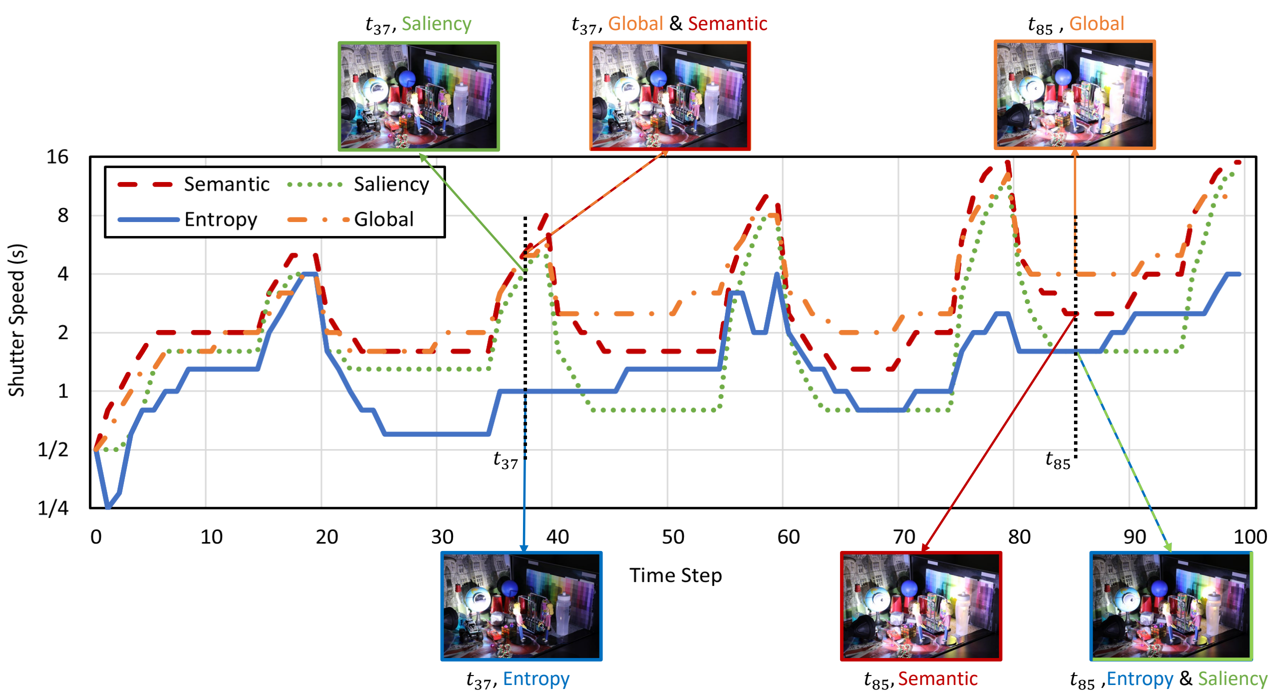

Figure 4: Scene 3 time plot visualizing how AE algorithms choose different exposures at various time steps. This scene contains a moving, flashing light and a mirror (high reflective object). Additionally, we visualize the images chosen by the AE algorithms at time steps 37 and 85.

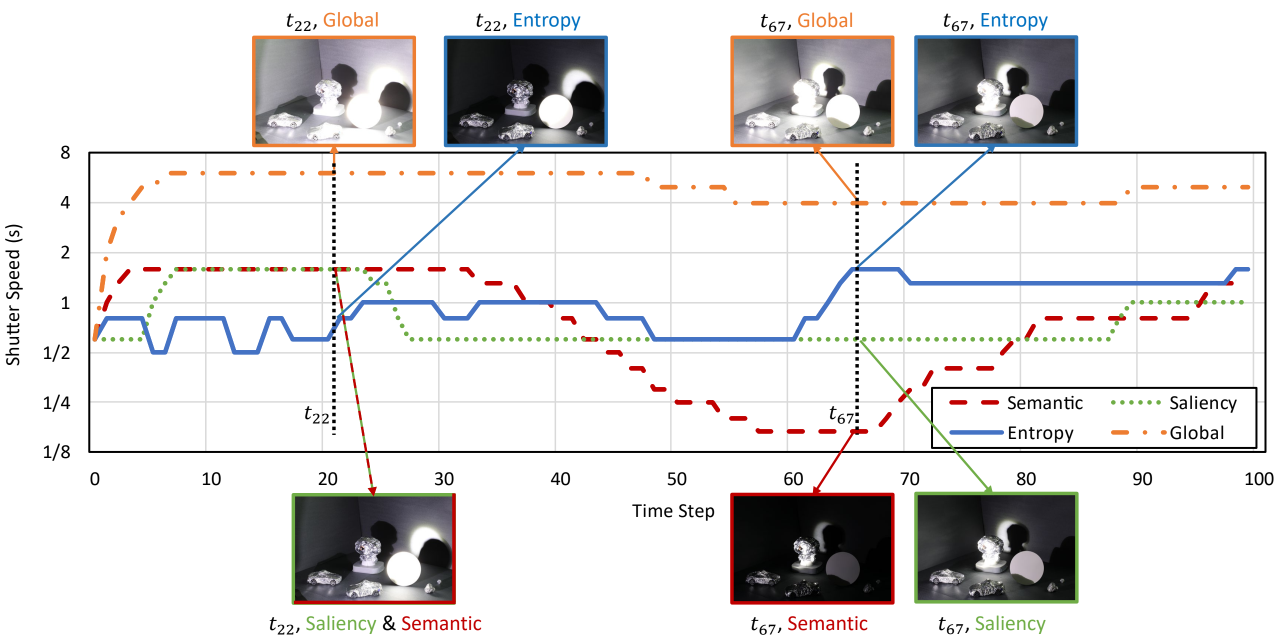

Figure 5: Scene 7 time plot visualizing how AE algorithms choose different exposures at various time steps. This scene contains a moving high-lumen light and several highly reflective objects (doll, ball, and cars). Additionally, we visualize the images chosen by the AE algorithms at time steps 22 and 67.

Figure 6: Scene 1 exposure stack (15s - $\frac{1}{2}$s) at 6 different time steps.

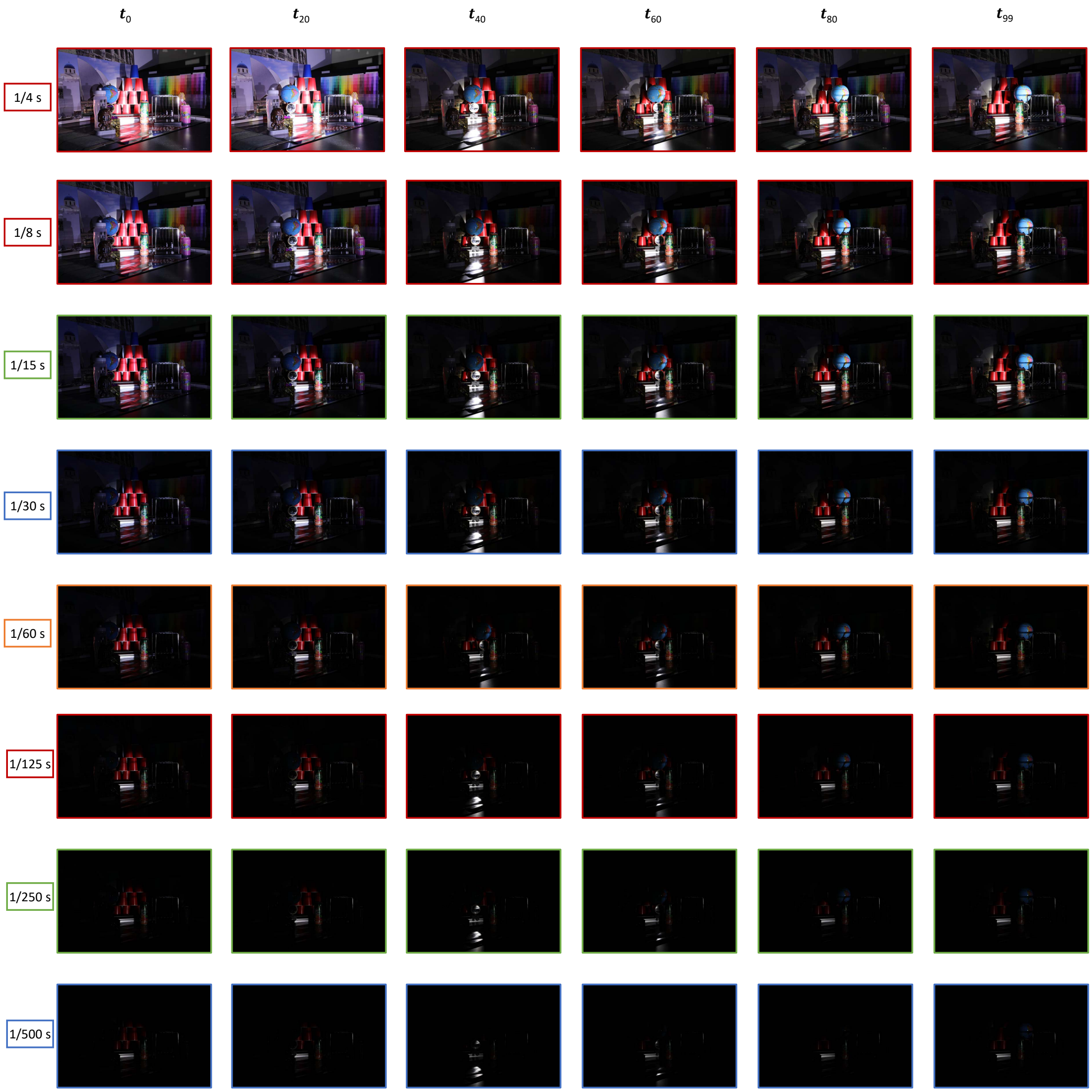

Figure 7: Scene 1 exposure stack ($\frac{1}{4}$s - $\frac{1}{500}$s) at 6 different time steps.

Figure 8: Scene 4 exposure stack (15s - $\frac{1}{2}$s) at 6 different time steps.

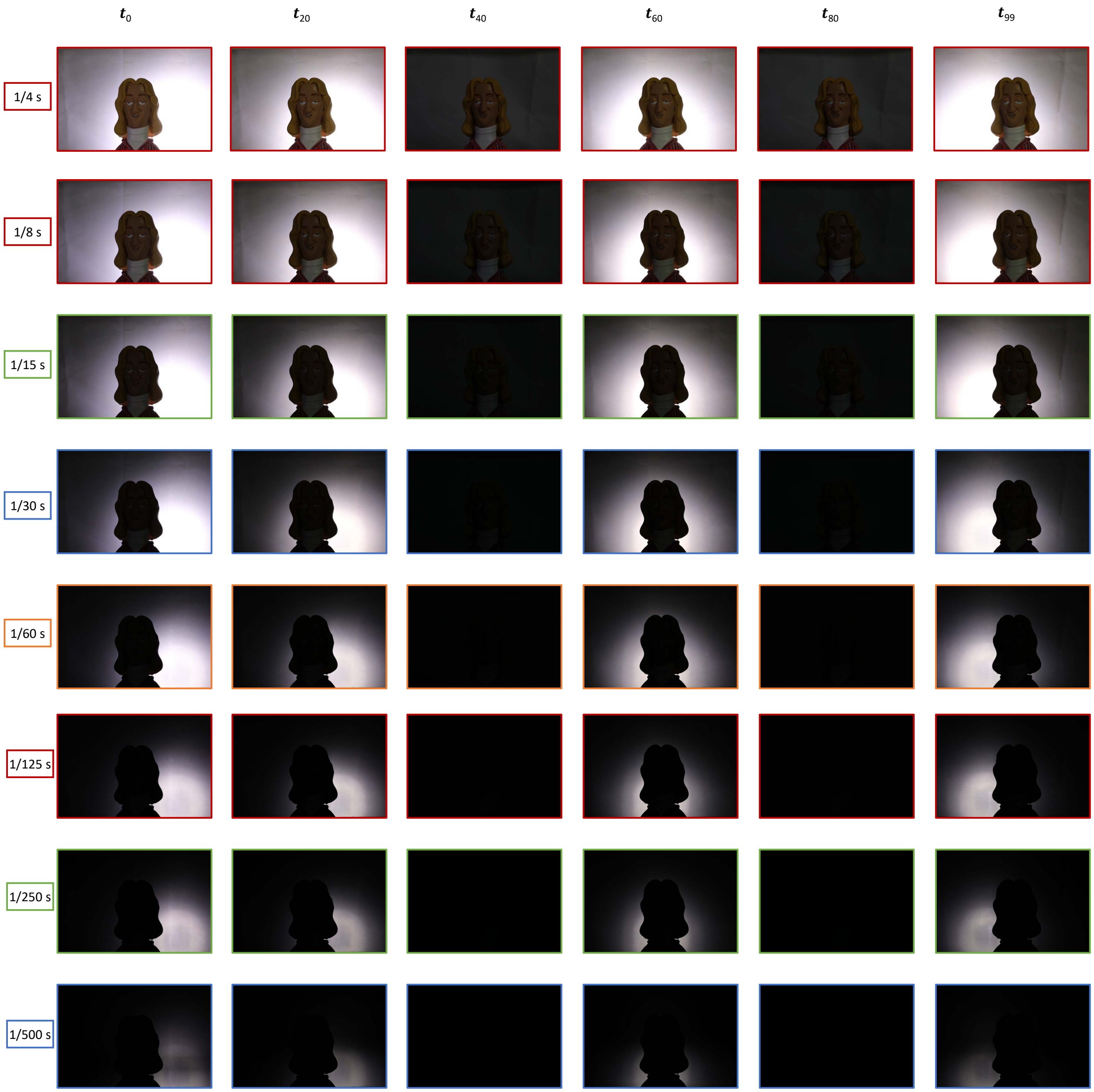

Figure 9: Scene 4 exposure stack ($\frac{1}{4}$s - $\frac{1}{500}$s) at 6 different time steps.

Figure 10: Scene 6 exposure stack (15s - $\frac{1}{2}$s) at 6 different time steps.

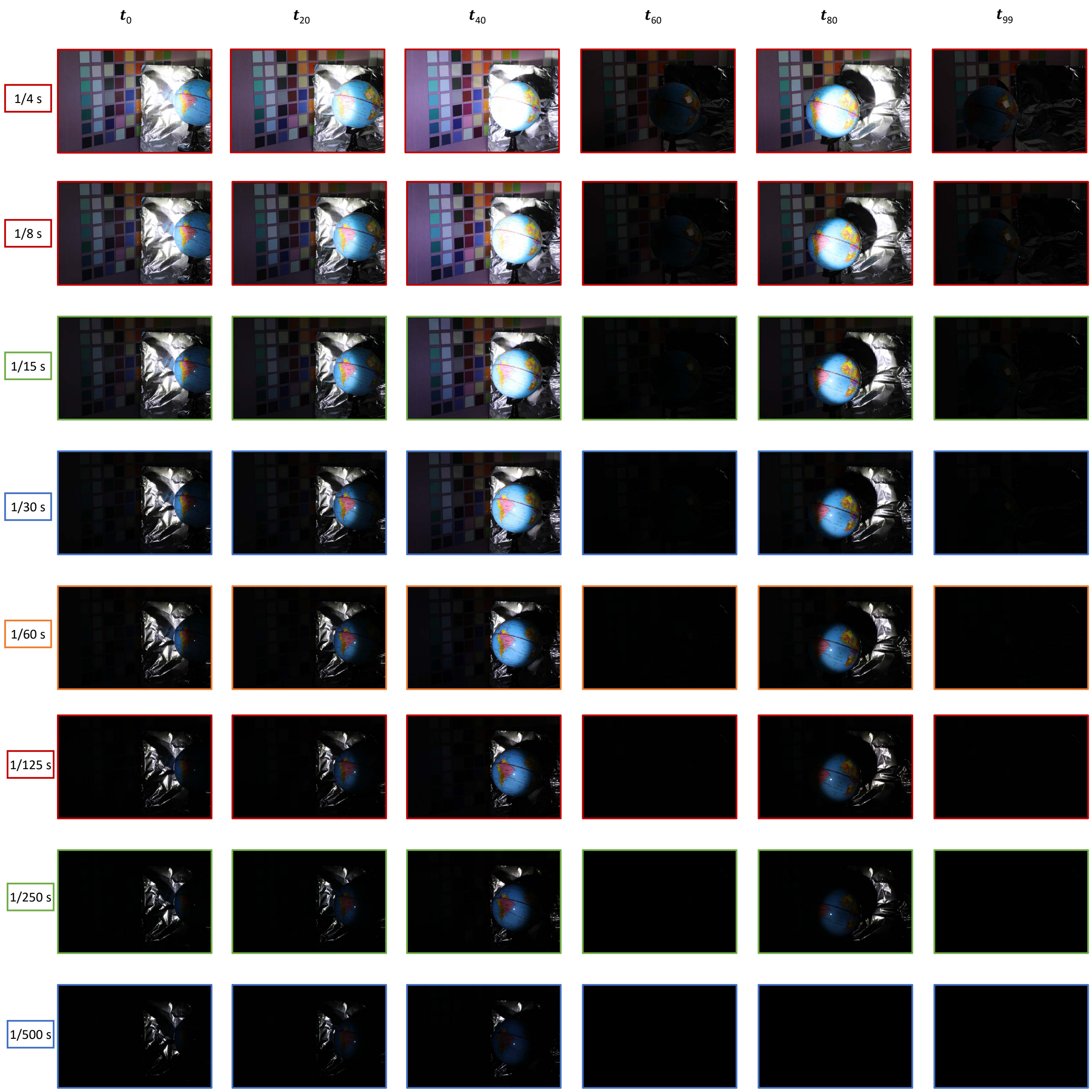

Figure 11: Scene 6 exposure stack ($\frac{1}{4}$s - $\frac{1}{500}$s) at 6 different time steps.

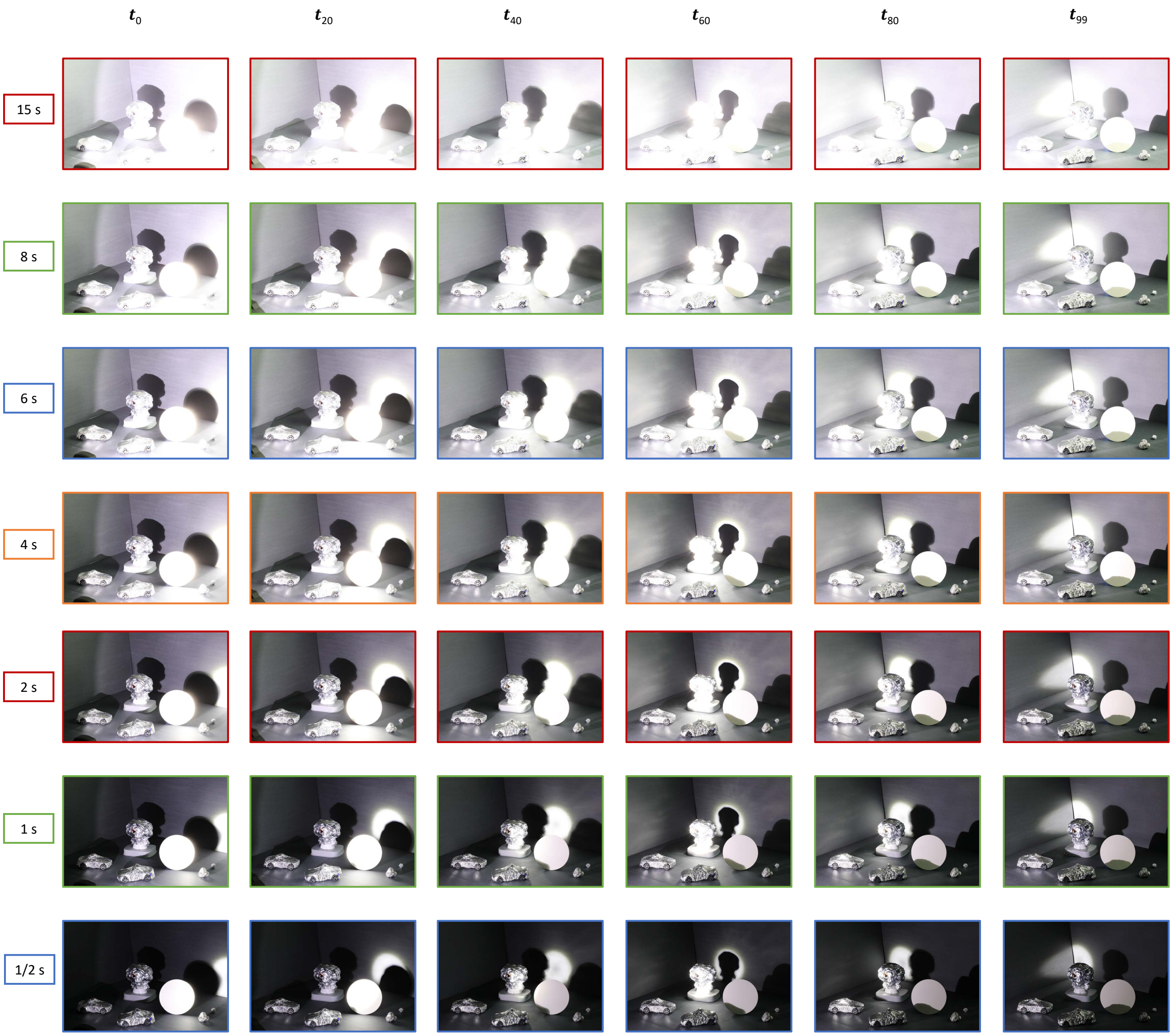

Figure 12: Scene 7 exposure stack (15s - $\frac{1}{2}$s) at 6 different time steps.

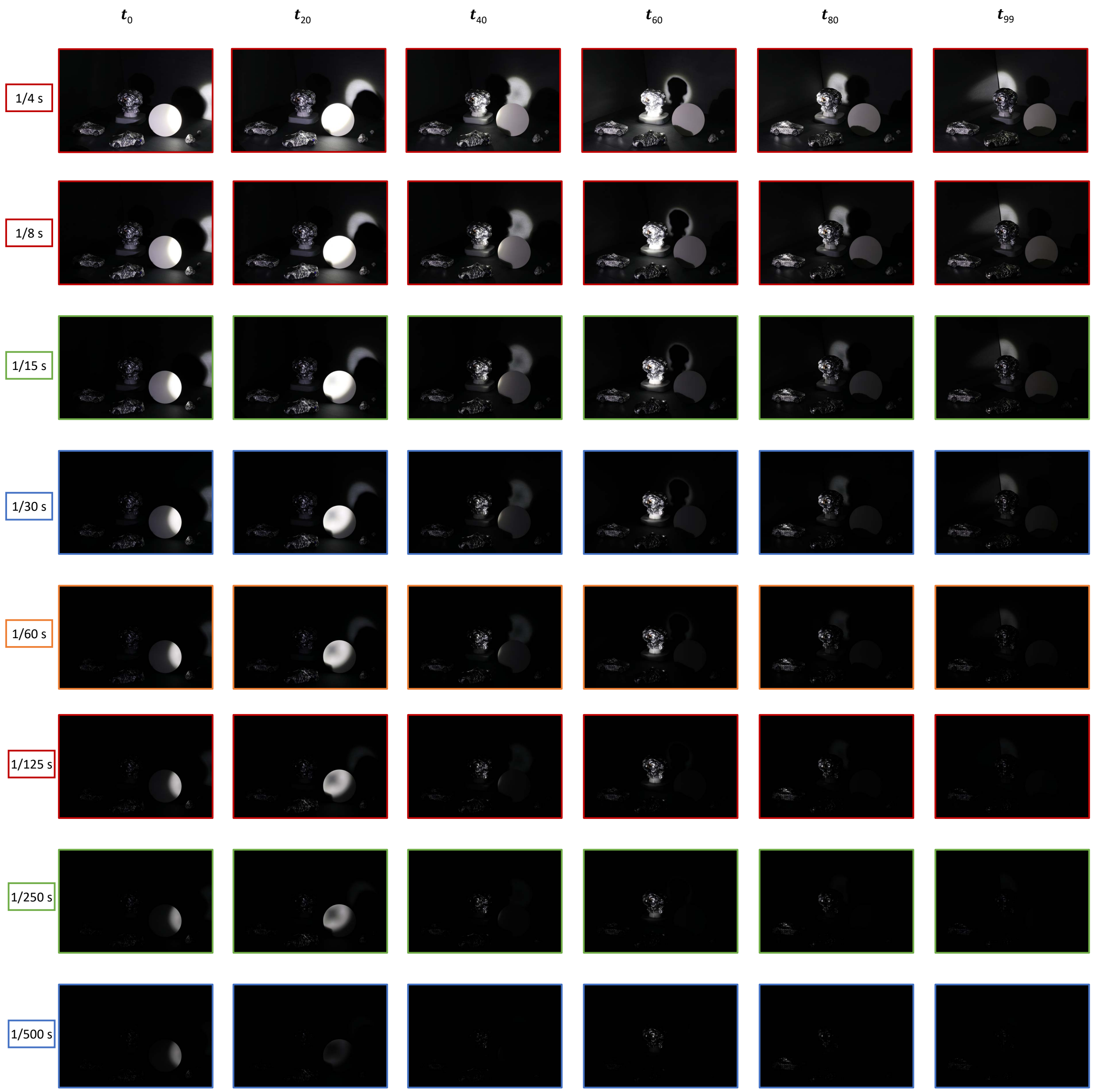

Figure 13: Scene 7 exposure stack ($\frac{1}{4}$s - $\frac{1}{500}$s) at 6 different time steps.

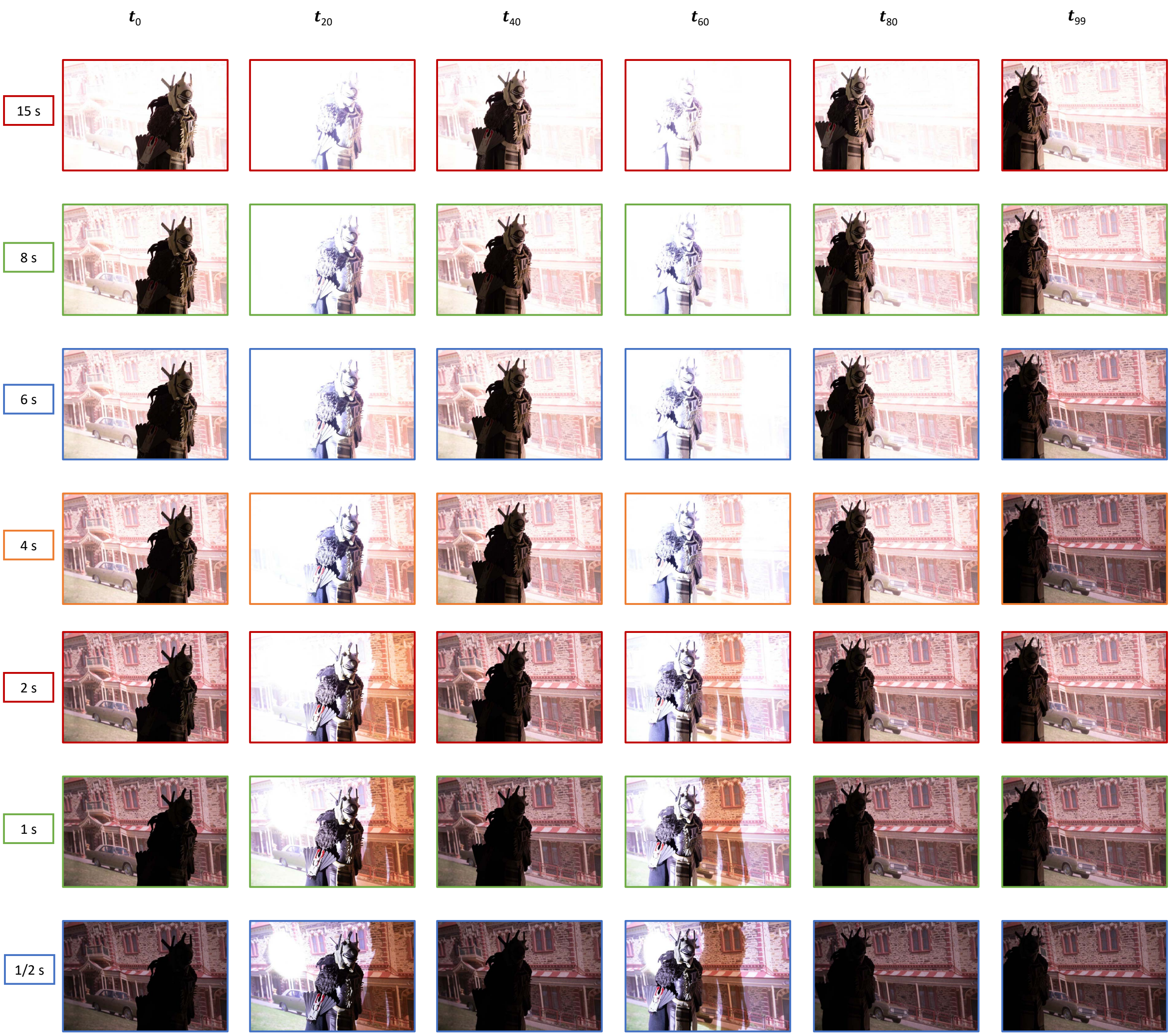

Figure 14: Scene 9 exposure stack (15s - $\frac{1}{2}$s) at 6 different time steps.

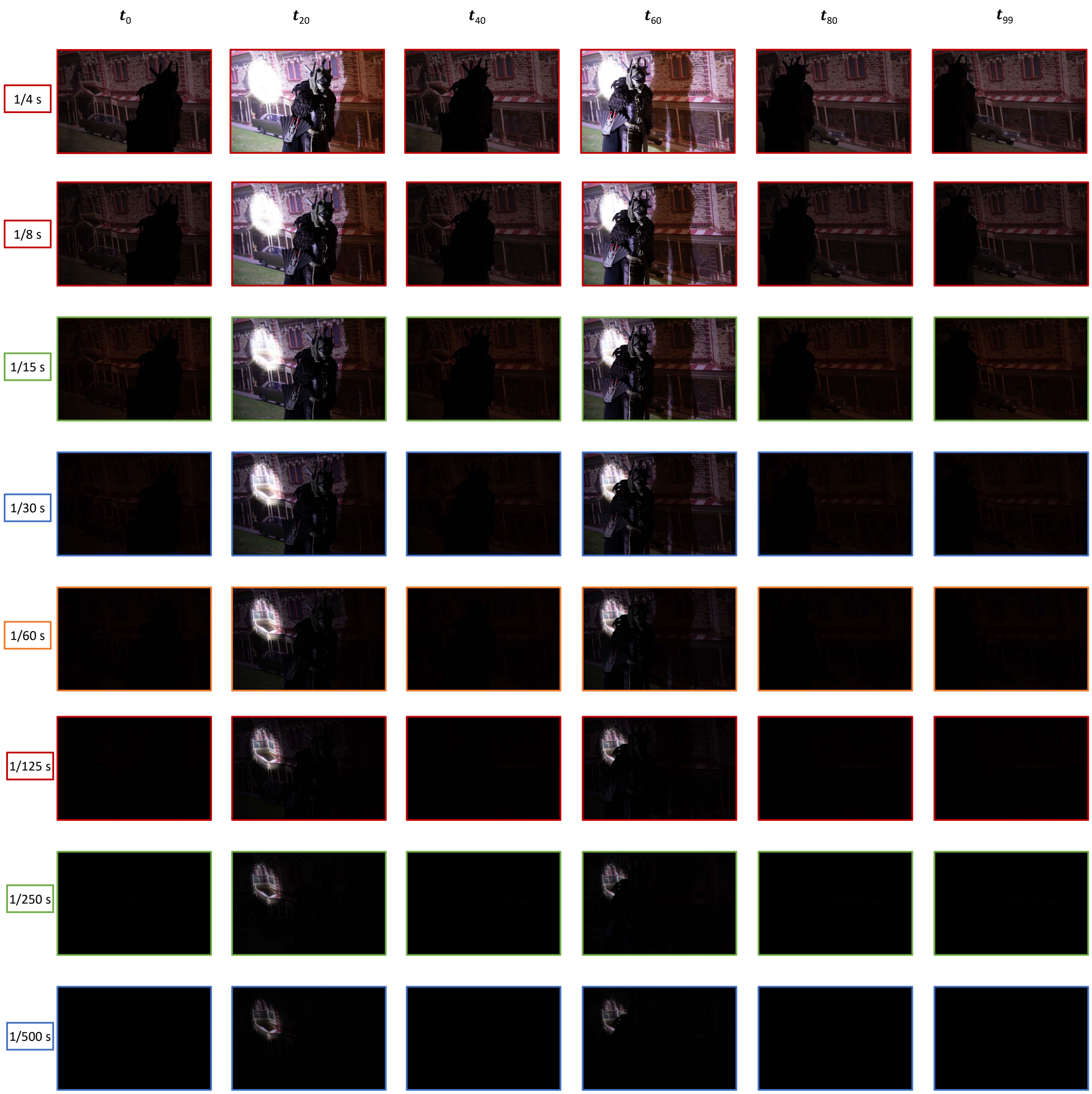

Figure 15: Scene 9 exposure stack ($\frac{1}{4}$s - $\frac{1}{500}$s) at 6 different time steps.

References

[1] Huimin Lu, Hui Zhang, Shaowu Yang, and Zhiqiang Zheng. A novel camera parameters auto-adjusting method based on image entropy. In *RoboCup 2009: Robot Soccer World Cup XIII 13*. Springer, 2010. 1

[2] Jingyi Ning, Tiejun Lu, Liyan Liu, Liye Guo, and Xiaofeng Jin. The optimization and design of the auto-exposure algorithm based on image entropy. In *8th International Congress on Image and Signal Processing*, 2015. 1

[3] Chi Zhang, Zheng You, and Shijie Yu. An automatic exposure algorithm based on information entropy. In *Sixth International Symposium on Instrumentation and Control Technology*, 2006. 1

[4] Jianming Zhang, Stan Sclaroff, Zhe Lin, Xiaohui Shen, Brian Price, and Radomír Měch. Minimum barrier salient object detection at 80 fps. In *ICCV*, 2015. 1, 2