Fast Single Image Reflection Suppression via Convex Optimization Supplementary Materials

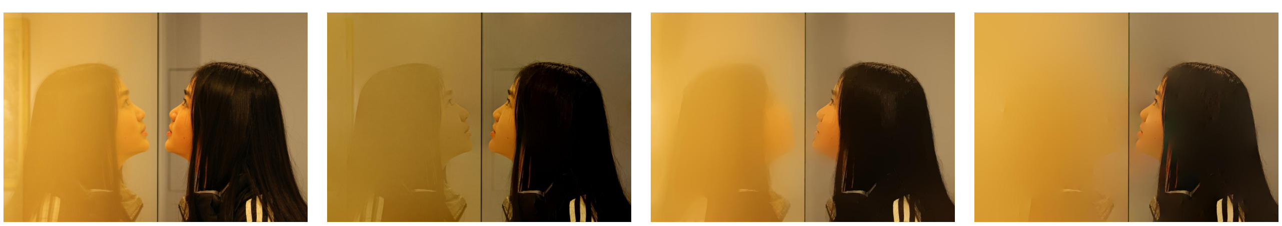
Yang Yang[1], Wenye Ma[2], Yin Zheng[3], Jian-Feng Cai[4], Weiyu Xu[1]
[1]University of Iowa, [2]Tencent, [3]Tencent AI Lab, [4]Hong Kong University of Science and Technology
yy.hz76@gmail.com, wenyema@tencent.com, yinzheng@tencent.com, jfcai@ust.hk, weiyu-xu@uiowa.edu

1. The Slider Demo

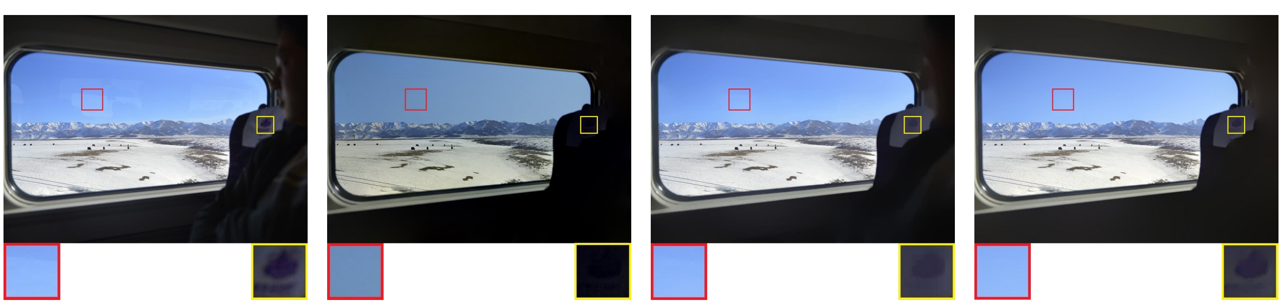
Please check the slider demo example (as shown in Fig. 7 in the original paper) to see the fast response of parameter tuning of the proposed model.
Our model's real-time parameter tuning feature gives users more flexibility on choosing h according to their own preferences. In contrast, real-time parameter tuning is impossible for other models in comparison because of the low efficiency. We consider this instantaneous/user-friendly parameter tuning as a significant improvement over existing approaches.

2. Additional Image Reflection Suppression Examples

We put a few more reflection-contaminated images from the Internet in Fig. 1 and Fig. 2 to demonstrate the performance of the proposed model together with existing approaches mentioned in the original paper. The parameters used and execution times are reported. We can see that the execution times of the proposed model outperform all other methods by a significant margin. MATLAB code is at https://github.com/yyhz76/reflectSuppress

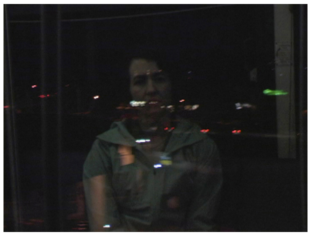


(1a) Input 1 (1b) Li and Brown time $= 21.38s$ (1c) Arvanitopoulos *et al.*, $\lambda = 0.003$, time $= 786s$ (1d) Proposed, $h = 0.055$, time $= 1.04s$



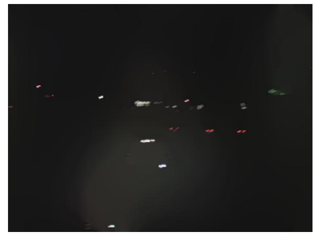
(1e) Input 2 (1f) Li and Brown time $= 7.07s$ (1g) Arvanitopoulos *et al.*, $\lambda = 0.0006$, time $= 1210s$ (1h) Proposed, $h = 0.017$, time $= 1.36s$

Figure 1: Additional examples

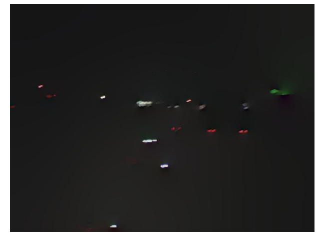


(2a) Input 3

(2b) Li and Brown
time $= 14.10s$



(2c) Arvanitopoulos *et al.*,
$\lambda = 0.01$, time $= 238s$



(2d) Proposed,
$h = 0.11$, time $= 0.28s$

(2e) Input 4

(2f) Li and Brown
time $= 36.31s$

(2g) Arvanitopoulos *et al.*,
$\lambda = 0.001$, time $= 1609s$

(2h) Proposed,
$h = 0.018$, time $= 2.14s$

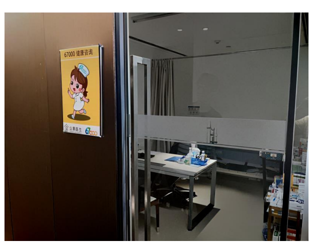
(2i) Input 5

(2j) Li and Brown
time $= 39.20s$

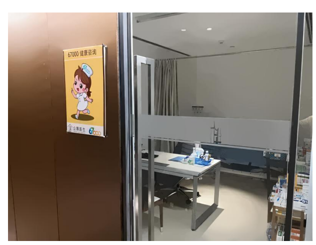
(2k) Arvanitopoulos *et al.*,
$\lambda = 0.005$, time $= 818s$

(2l) Proposed,
$h = 0.06$, time $= 1.10s$

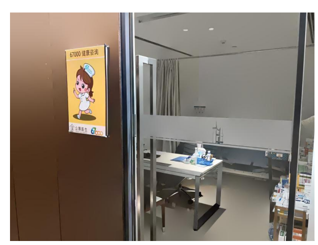
(2m) Input 6



(2n) Li and Brown
time $= 1.65s$



(2o) Arvanitopoulos *et al.*,
$\lambda = 0.002$, time $= 387s$

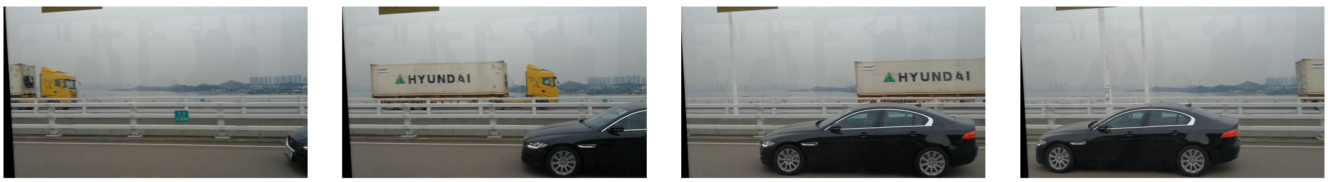


(2p) Proposed,
$h = 0.04$, time $= 0.40s$

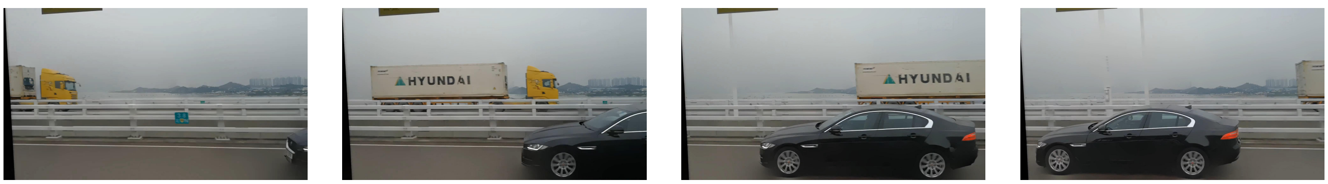
Figure 2: Additional examples (cont.)

3. An Extension to Video Dereflection

The high efficiency of the proposed model motivates us to further extend our approach to high-definition (HD) videos that contain reflection. This is just a first attempt which could be developed as a future direction. Two sample video clips (MPEG-4 format) captured by smartphone are used to demonstrate the performance. We process each frame of a video using our model and reassemble the frames together to form the dereflected video. Selected video frames are shown in Fig. 3 (See the attached video file `video dereflection demo.mp4` for the complete videos). The reassembled videos have the reflection completely removed. In addition, they also demonstrate good color reproduction and continuity across frames. No in-frame artifact or temporal flickering is observed. The details of video samples and execution times are listed in Table 1. We can see that our method achieves high efficiency on 1080p HD video reflection suppression, which is impossible for other models in comparision because of the low efficiency.



(3a) Video Input 1, selected frames before dereflection



(3b) Video Input 1, selected frames after dereflection

(3c) Video Input 2, selected frames before dereflection

(3d) Video Input 2, selected frames after dereflection

Figure 3: Video reflection suppression examples. Fig. 3a: selected video frames taken from the inside of a moving bus. Notice the moving vehicles outside and the reflection of passengers and handrails inside the bus; Fig. 3b: dereflected frames of Fig. 3a; Fig. 3c: selected video frames taken from the inside of a moving train. Notice the moving signal tower outside and the reflection of the window; Fig. 3d: dereflected frames of Fig. 3c. Best viewed on screen

Table 1: Reflection suppression on sample videos in Fig. 3

Video	Resolution	Length (*sec*)	Number of Frames	Execution Time (*sec*)
Input 1	1080×1920	5.03	151	252.25
Input 2	1080×1920	6.62	197	336.81