Just Noticeable Blur Detection and Estimation Supplementary Material

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1. Just Noticeable Blur in Clear Region

Fig. 1 shows an image captured by a Sony DSLR-A100 camera with Carl Zeiss 35mm F2.8 lens set under F/5.6. We focus on the top characters, which should be sharp. But this region still contains about 2-pixel blurriness in its original resolution. The bottom characters, on the contrary, contain more severe 4 - 10 pixel blurriness. This fact manifests that just noticeable blur occurs in all images captured by cameras in their original resolution. Extracting information from it is extremely important.

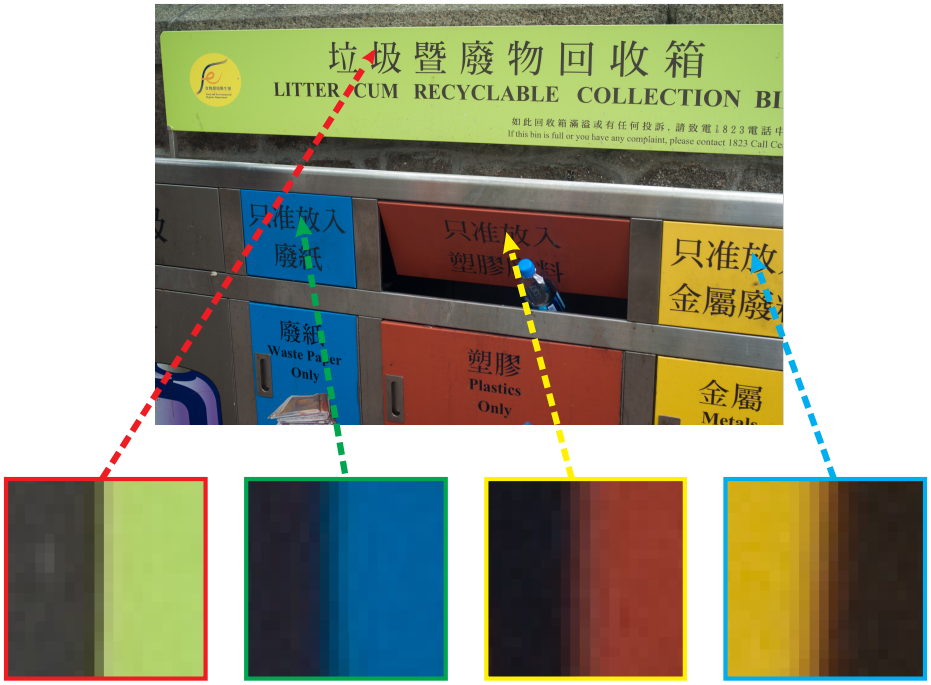


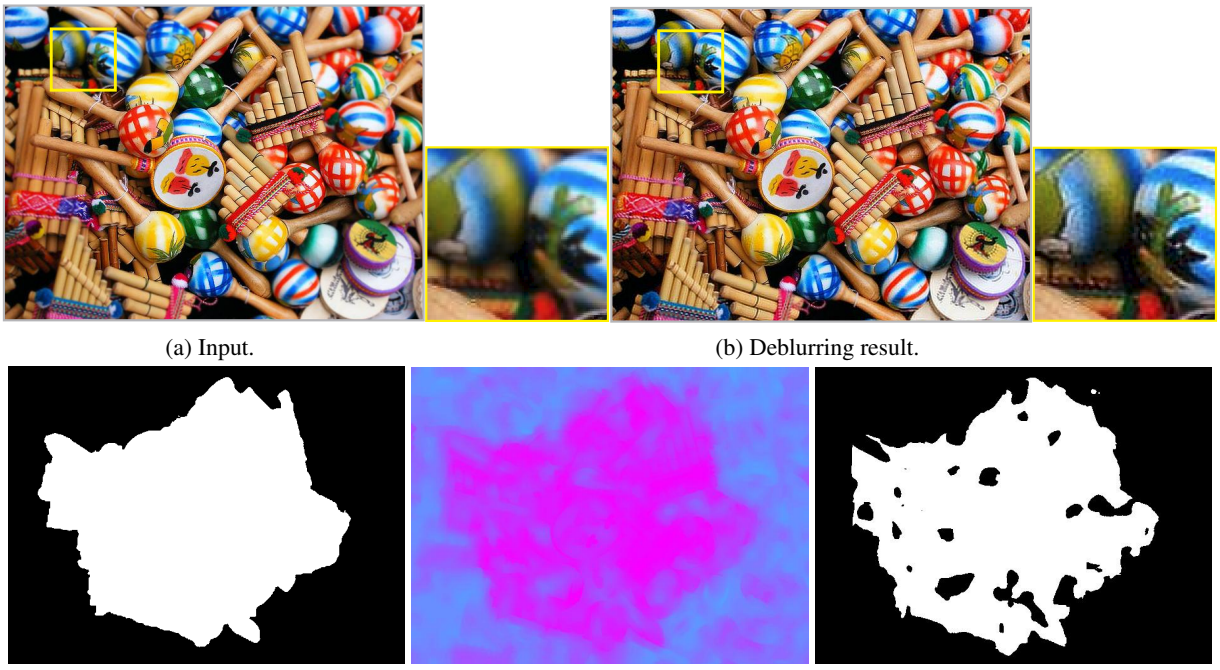
Figure 1. Just noticeable blur illustration in a clear region.

2. More Results

Depth-aware image rendering Our defocus map, is closely related to depth, which can be regarded as a primary depth representation. Therefore, we can synthesize a stereo pair of images by rendering the corresponding depth based on the input color image from new viewpoints. We first quantize the depth map into 10 different layers and assigned a predefined depth value to each layer. The two novel views are on the left and right of the original image, given the disparity we set. Fig. 2

(a) Input and Feature (b) Left and Right Image (c) Close-up (d) An Anaglyph 3D Image

Figure 2. Stereo pair generation using our estimated blur map.



(a) Input. (b) Deblurring result.

(c) Ground truth mask. (d) Feature map. (e) Blur mask.

Figure 3. Deblurring using our blur estimate.

shows an example. Given the input and defocus map in (a), stereo pairs are generated in (b). The closeup is shown in (c). We further display a 2D version via 3D red cyan glasses in (d).

Deblurring using the blur estimate We provide another example on image deblurring to estimate blur mask and blur scale using our estimated blurriness feature. The result is shown in Fig. 3.

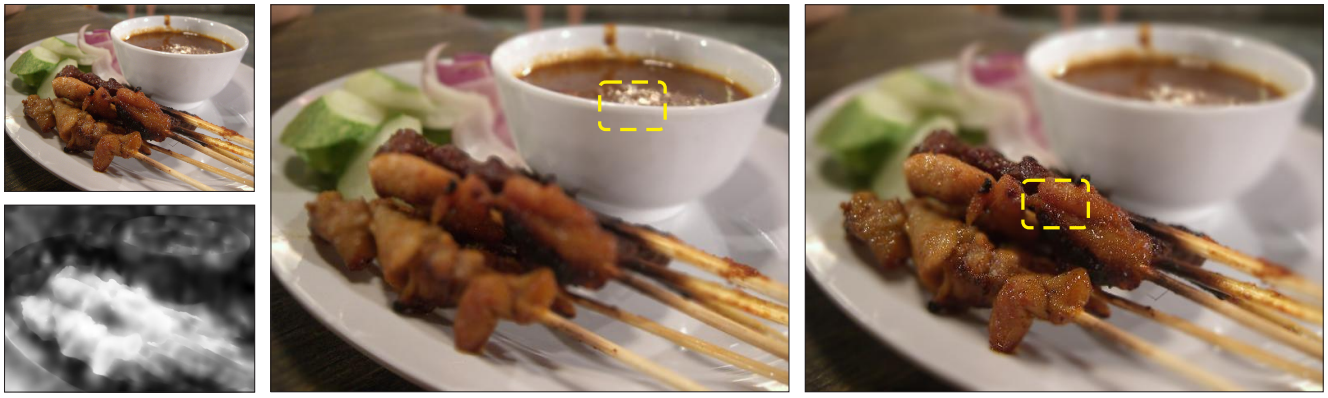
Refocus using blur estimate We also include another examples on image refocusing using our blur maps. The different refocusing effects demonstrate the usefulness of our estimated blur maps.

Blur map comparison We include a few examples to compare our sparsity based feature with other blur estimation approaches including [1, 3, 2, 7, 6, 5, 4]. The results are illustrated in Figs. 5, 6, 7, 8, 9, 10, and 11 respectively.

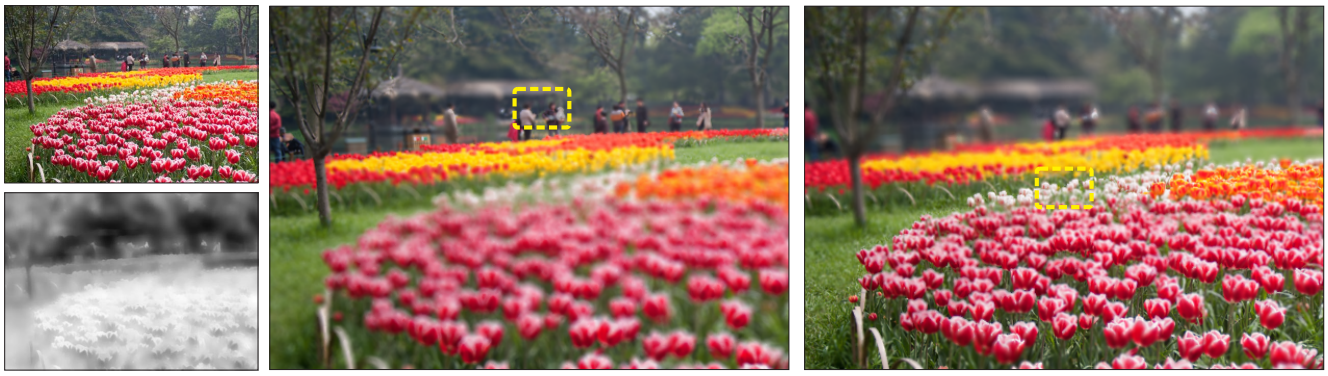
References

[1] S. Bae and F. Durand. Defocus magnification. In *Computer Graphics Forum*, volume 26, pages 571–579, 2007.

(a) Input & Feature (b) Refocus result 1 (c) Refocus result 2



(a) Input & Feature (b) Refocus result 1 (c) Refocus result 2



(a) Input & Feature (b) Refocus result 1 (c) Refocus result 2

Figure 4. Refocusing using our blur map. We show two different refocusing results. The dashed boxes highlight sharpened regions.

[2] A. Chakrabarti, T. Zickler, and W. T. Freeman. Analyzing spatially-varying blur. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 2512–2519, 2010.

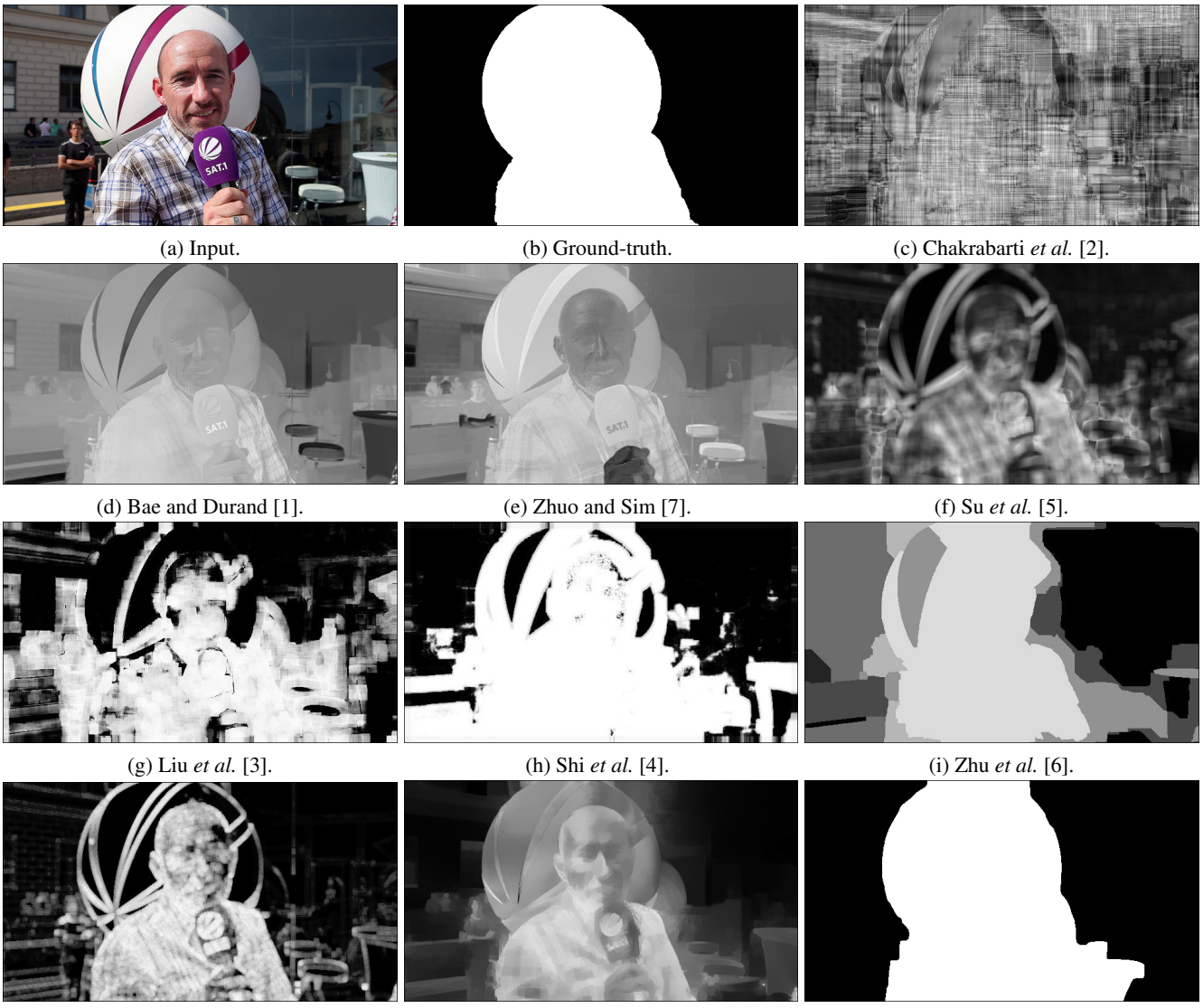
[3] R. Liu, Z. Li, and J. Jia. Image partial blur detection and classification. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 1–8, 2008.

[4] J. Shi, L. Xu, and J. Jia. Discriminative blur detection features. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2014.

[5] B. Su, S. Lu, and C. L. Tan. Blurred image region detection and classification. In *ACM international conference on Multimedia*, pages 1397–1400, 2011.

[6] X. Zhu, S. Cohen, S. Schiller, and P. Milanfar. Estimating spatially varying defocus blur from a single image. *IEEE Transactions on Image Processing (TIP)*, 22(12):4879–4891.

[7] S. Zhuo and T. Sim. Defocus map estimation from a single image. *Pattern Recognition*, 44(9):1852–1858, 2011.



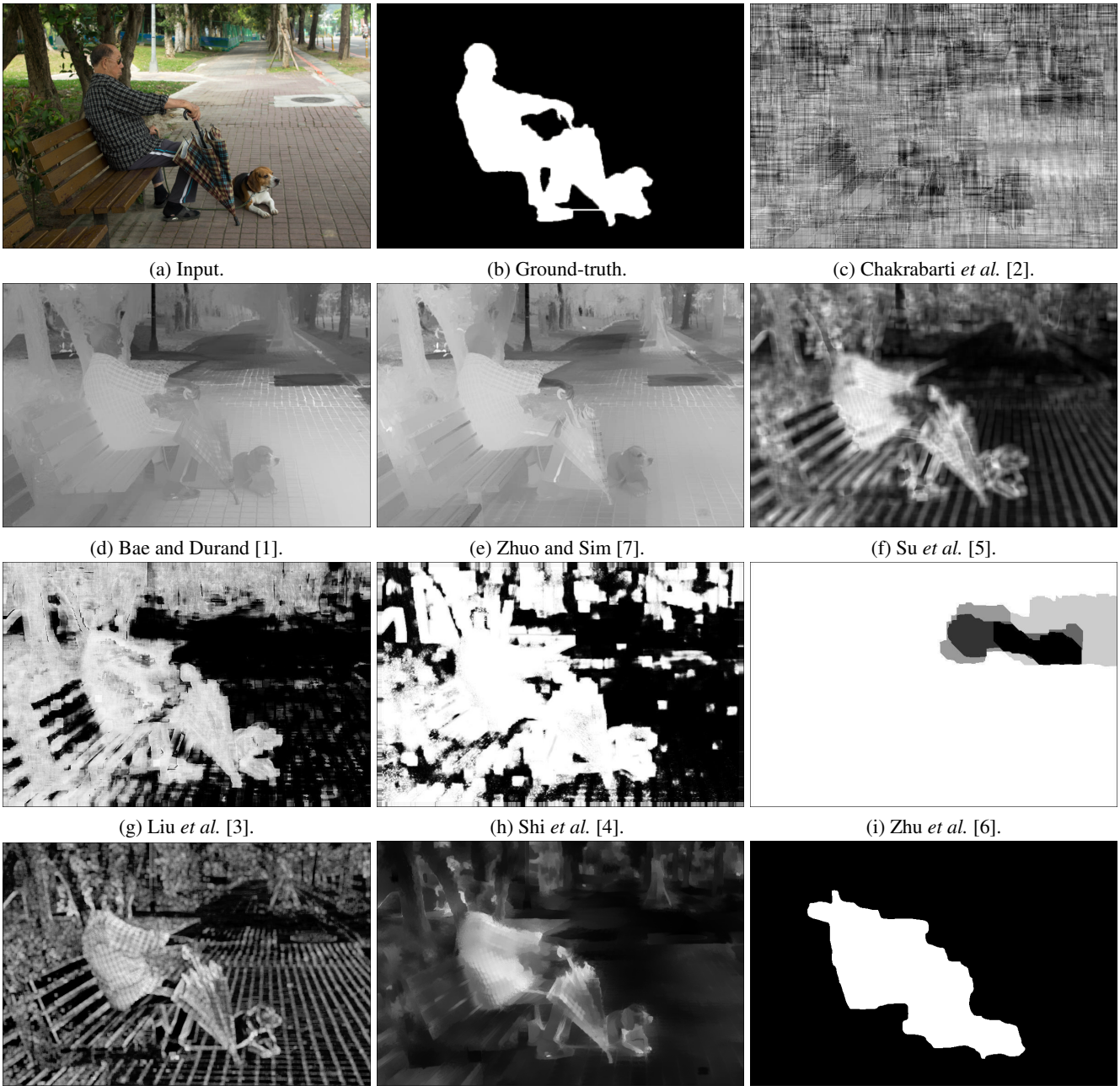
(a) Input. (b) Ground-truth. (c) Chakrabarti *et al.* [2].

(d) Bae and Durand [1]. (e) Zhuo and Sim [7]. (f) Su *et al.* [5].

(g) Liu *et al.* [3]. (h) Shi *et al.* [4]. (i) Zhu *et al.* [6].

(j) Our raw feature. (k) Our final blur map. (l) Our binary map.

Figure 5. Blur map comparison.



(a) Input. (b) Ground-truth. (c) Chakrabarti *et al.* [2].

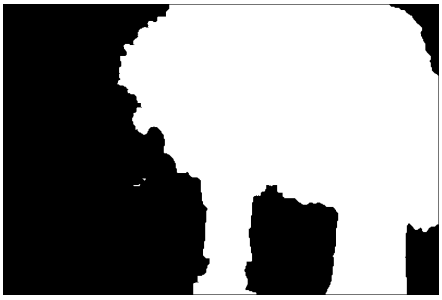
(d) Bae and Durand [1]. (e) Zhuo and Sim [7]. (f) Su *et al.* [5].

(g) Liu *et al.* [3]. (h) Shi *et al.* [4]. (i) Zhu *et al.* [6].

(j) Our raw feature. (k) Our final blur map. (l) Our binary map.

Figure 6. Blur map comparison.

(a) Input.



(b) Ground-truth.

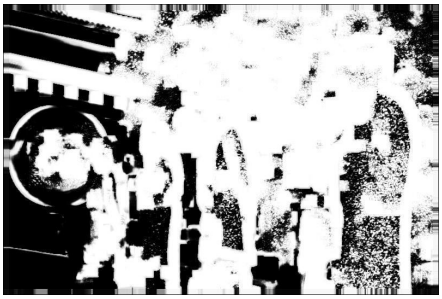
(c) Chakrabarti *et al.* [2].

(d) Bae and Durand [1].

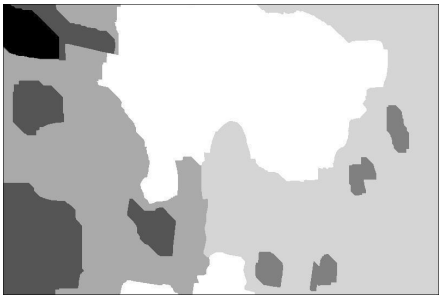
(e) Zhuo and Sim [7].

(f) Su *et al.* [5].

(g) Liu *et al.* [3].



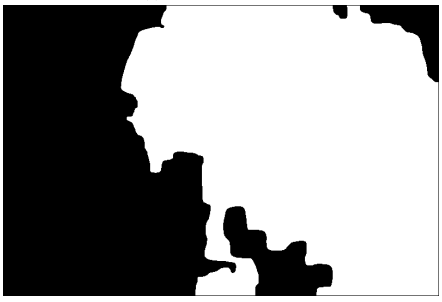
(h) Shi *et al.* [4].



(i) Zhu *et al.* [6].

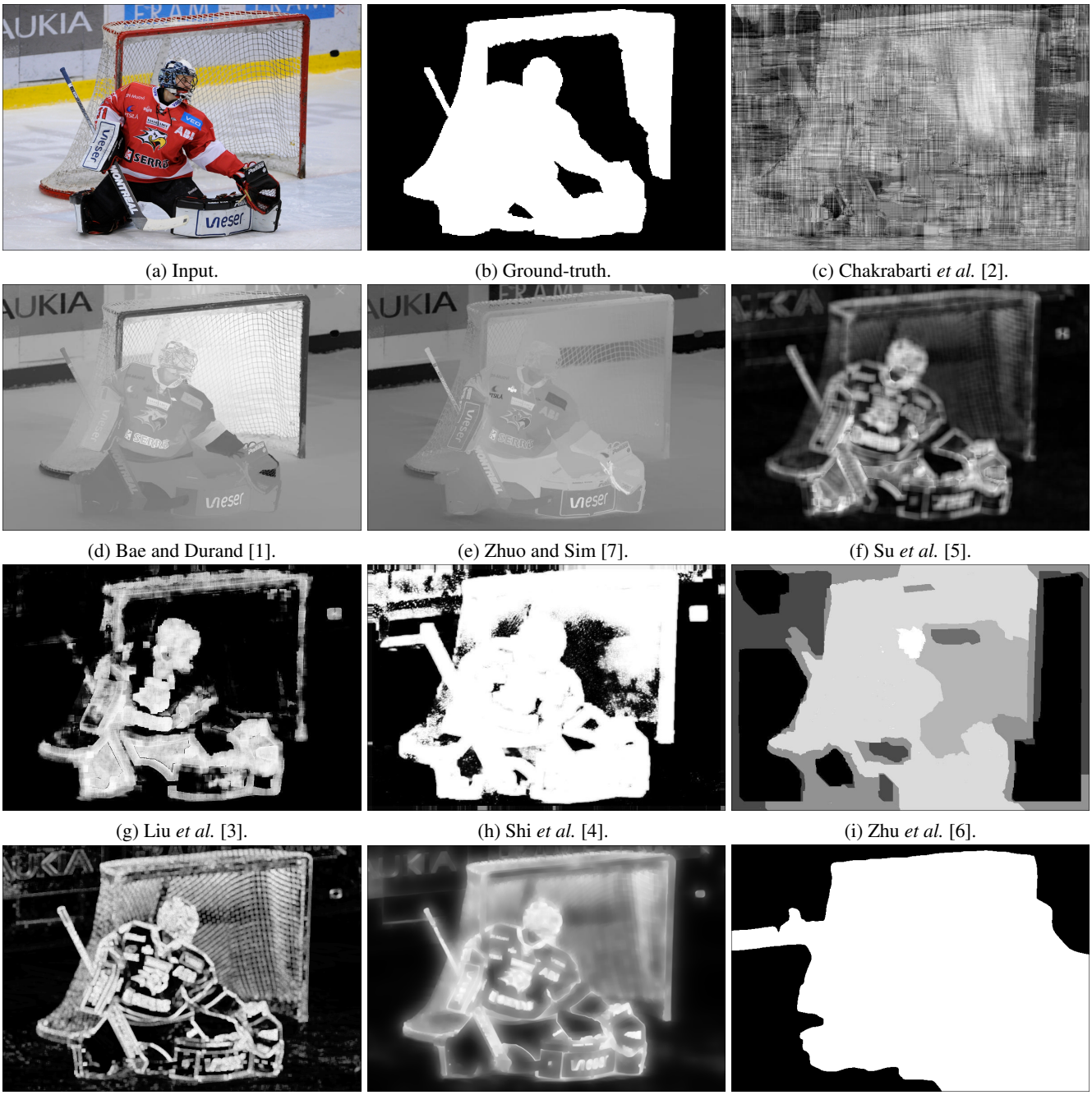
(j) Our raw feature.

(k) Our final blur map.



(l) Our binary map.

Figure 7. Blur map comparison.



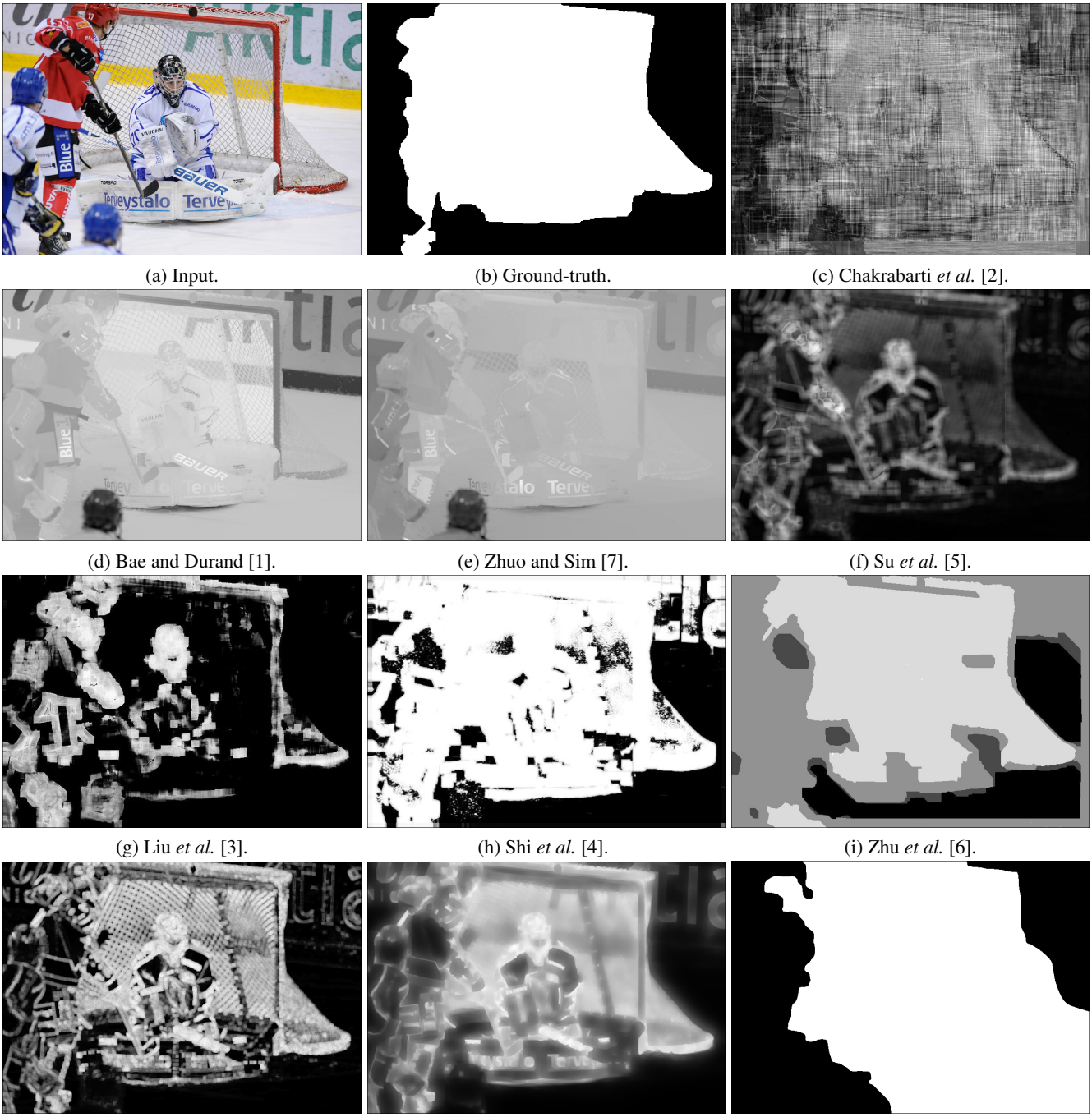
(a) Input. (b) Ground-truth. (c) Chakrabarti *et al.* [2].

(d) Bae and Durand [1]. (e) Zhuo and Sim [7]. (f) Su *et al.* [5].

(g) Liu *et al.* [3]. (h) Shi *et al.* [4]. (i) Zhu *et al.* [6].

(j) Our raw feature. (k) Our final blur map. (l) Our binary map.

Figure 8. Blur map comparison.



(a) Input. (b) Ground-truth. (c) Chakrabarti *et al.* [2].

(d) Bae and Durand [1]. (e) Zhuo and Sim [7]. (f) Su *et al.* [5].

(g) Liu *et al.* [3]. (h) Shi *et al.* [4]. (i) Zhu *et al.* [6].

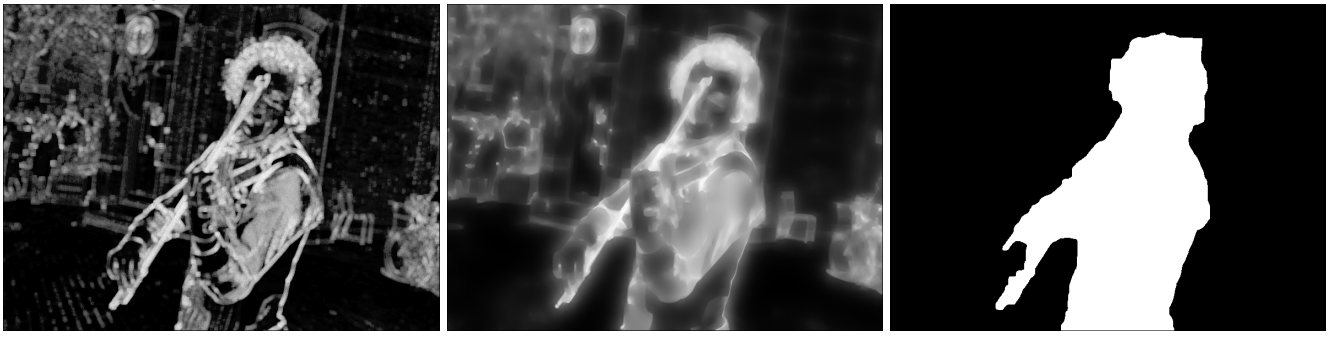
(j) Our raw feature. (k) Our final blur map. (l) Our binary map.

Figure 9. Blur map comparison.

(a) Input. (b) Ground-truth. (c) Chakrabarti *et al.* [2].

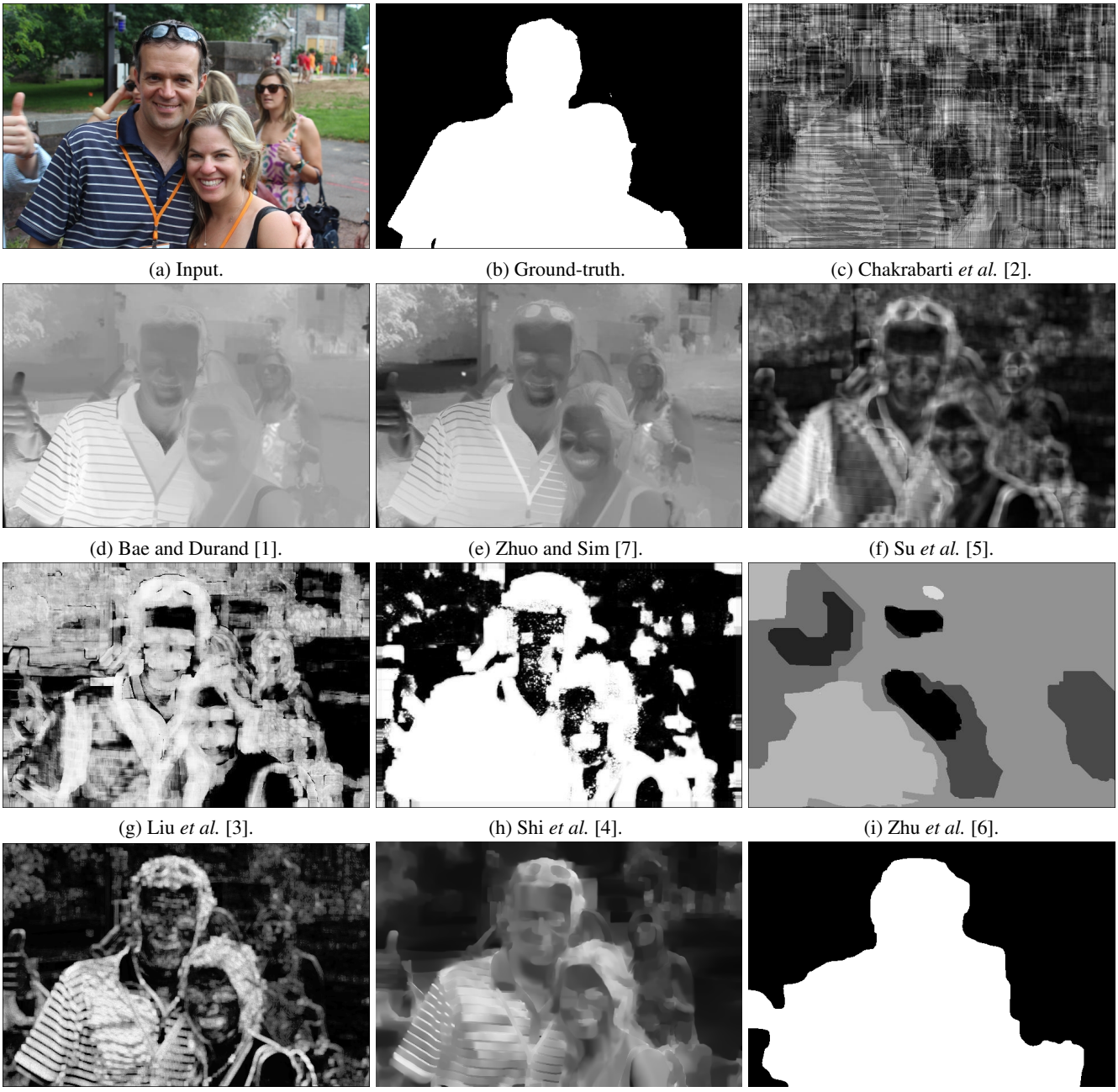
(d) Bae and Durand [1]. (e) Zhuo and Sim [7]. (f) Su *et al.* [5].

(g) Liu *et al.* [3]. (h) Shi *et al.* [4]. (i) Zhu *et al.* [6].



(j) Our raw feature. (k) Our final blur map. (l) Our binary map.

Figure 10. Blur map comparison.



(a) Input. (b) Ground-truth. (c) Chakrabarti *et al.* [2].

(d) Bae and Durand [1]. (e) Zhuo and Sim [7]. (f) Su *et al.* [5].

(g) Liu *et al.* [3]. (h) Shi *et al.* [4]. (i) Zhu *et al.* [6].

(j) Our raw feature. (k) Our final blur map. (l) Our binary map.

Figure 11. Blur map comparison.