

Deep Fully Convolutional Regression Networks for Single Image Haze Removal Supplementary Material

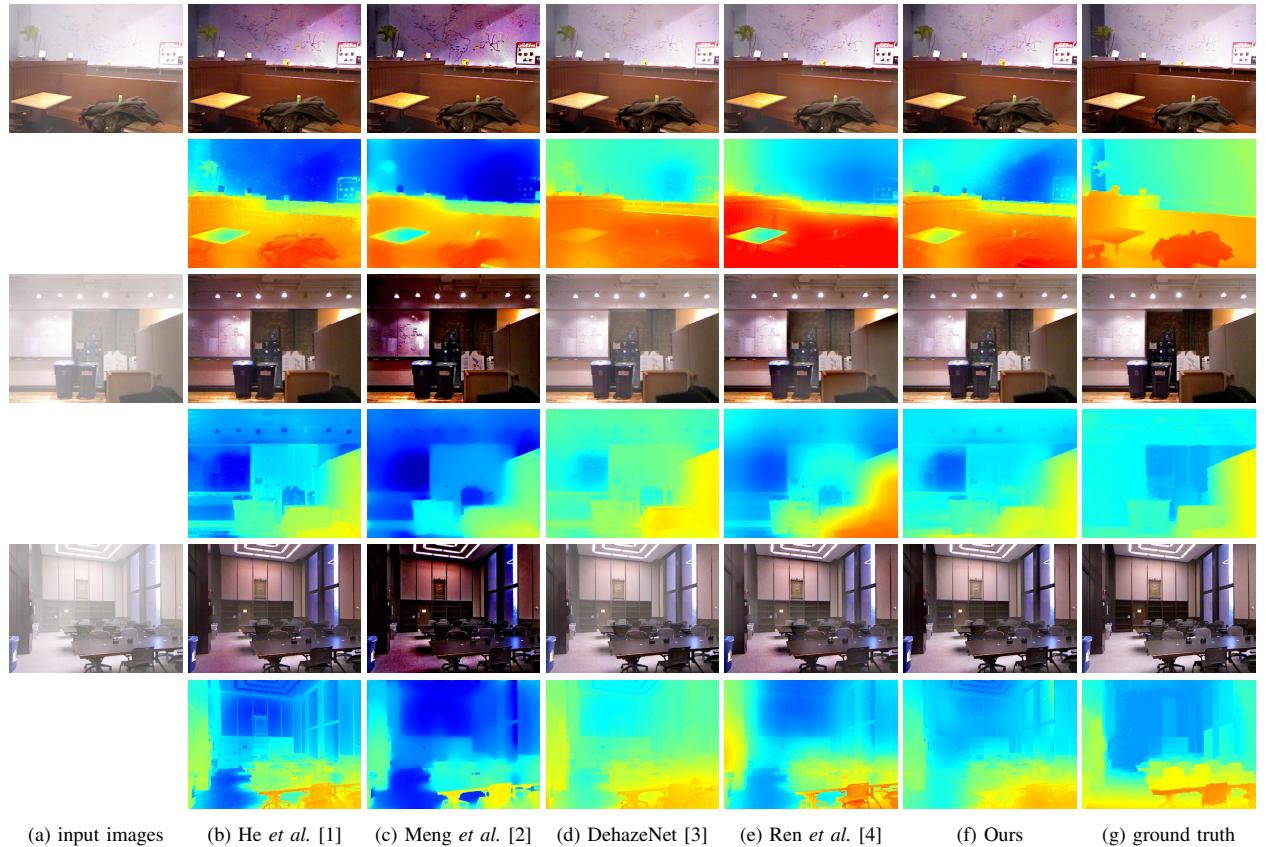
Xi Zhao #¹, Keyan Wang #², Yunsong Li #³, Jiaojiao Li #⁴

State Key Laboratory of Integrated Service Network, Xidian University, Xi'an 710071, China

¹ xizhao24@gmail.com, ^{2,3}{kywang, ysli}@mail.xidian.edu.cn, ⁴ jjli@xidian.edu.cn

I. MORE VISUAL COMPARISON ON SYNTHETIC IMAGES

Fig. 1 shows some dehazed images by different method. It is obvious that He *et al.*'s [1] and Meng *et al.*'s [2] results in Fig. 1(b) and 1(c) are quite different from the ground truth images (see Fig. 1(g)), where become much darker and contain color distortions. Although DehazeNet's [3] results in Fig. 1(d) are more similar to ground truth than Fig. 1(b) and 1(c), there are still some haze in their results (see the second hazy image and their corresponding dehazed results by DehazeNet in Fig. 1(d)). By observing the images in Fig. 1(e), we can find that Ren *et al.*'s [4] result have similar problems to them. For example, the first and third dehazed images in Fig. 1(e) still exist haze in the desk. Additionally, the second image contain color distortions in the wall. In contrast, our results shown in Fig. 1(f) maintain the original colors of the objects and have less color distortions.



(b) He *et al.* [1] (c) Meng *et al.* [2] (d) DehazeNet [3] (e) Ren *et al.* [4] (f) Ours (g) ground truth

Fig. 1. Qualitative comparison of different methods on the NYU [5] synthetic haze dataset.

II. MORE VISUAL COMPARISON ON READ-WORLD IMAGES

We evaluate our proposed algorithm against the state-of-the-art methods including He *et al.* [1], Meng *et al.* [2]¹, Cai *et al.*'s DehazeNet [3]², Ren *et al.* [4]³ on more real-world images as shown in Fig. 2 to Fig. 19.



Fig. 2. Visual comparisons for real image dehazing. The dehazed results in [1], [2], [4] have color distortions in the sky regions, and DehazeNet's [3] result exists haze in Fig. 2(d). In contrast, our result is visually sharper and clearer than others.

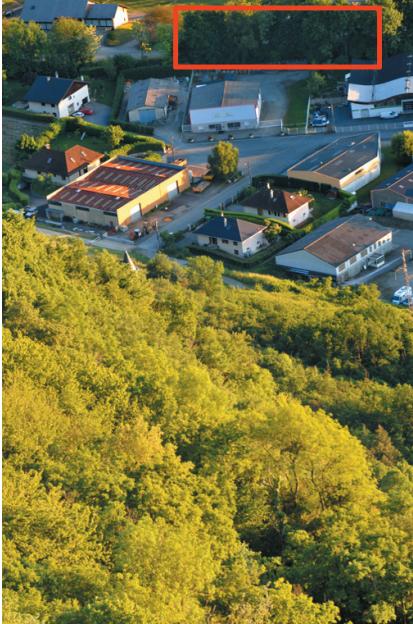
¹<http://www.escience.cn/people/menggaofeng/research.html>

²<https://github.com/caibolun/DehazeNet>

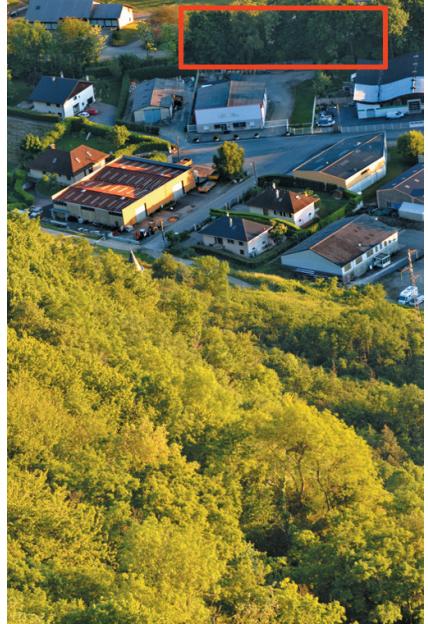
³<https://sites.google.com/site/renwenqi888/research/dehazing/mscnnndehazing>



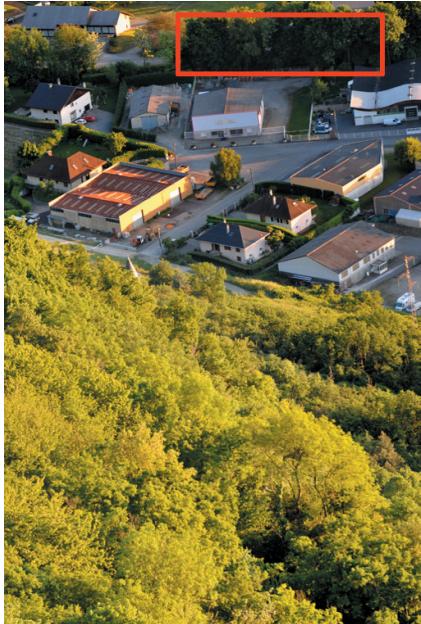
(a) hazy image



(b) He *et al.* [1]



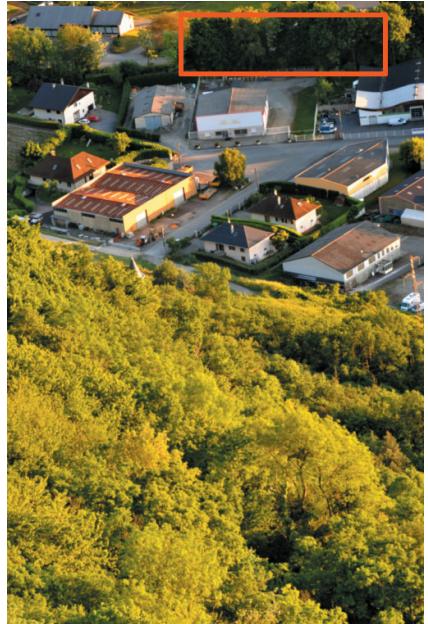
(c) Meng *et al.* [2]



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 3. Visual comparisons for real image dehazing. The dehazed results in Fig. 3(b), Fig. 3(c), Fig. 3(d) and Fig. 3(e) have hue distortions in the road regions and over-saturated regions in the red rectangles. In contrast, our result in Fig. 3(f) contains natural color information.



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 4. Visual comparisons for real image dehazing. The results generated by He *et al.* [1] and Meng *et al.* [2] failed to recover the sky regions as shown in Fig. 4(b) and Fig. 4(c). DehazeNet [3] and Ren *et al.* [4]'s results contain haze as shown in Fig. 4(d) and Fig. 4(e).



Fig. 5. Visual comparisons for real image dehazing. The dehazed results in Fig. 5(b) and Fig. 5(c) are all over-estimated the sky regions. DehazeNet [3] and Ren *et al.* [4]'s results contain haze in the red rectangle region as shown in Fig. 5(d), Fig. 5(e) and Fig. 5(f).



(a) hazy image



(b) He et al. [1]



(c) Meng et al. [2]



(d) DehazeNet [3]

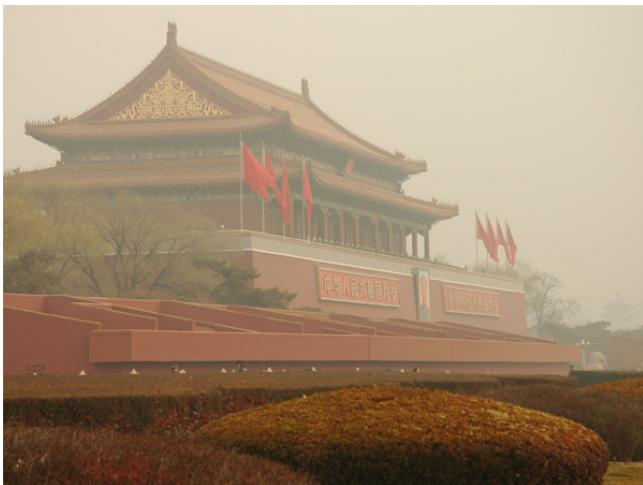


(e) Ren et al. [4]

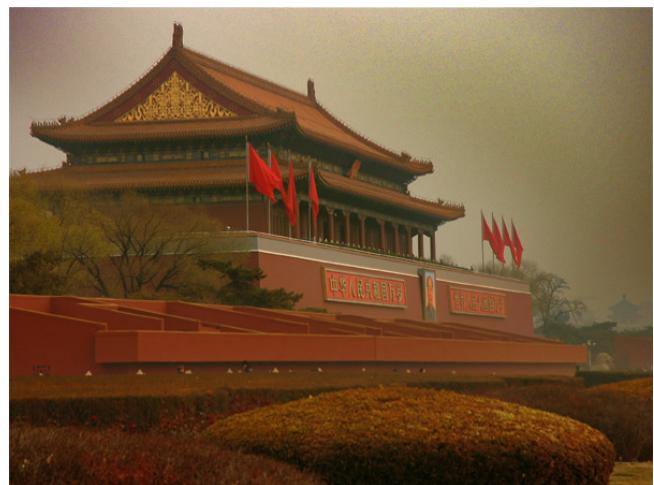


(f) Our result

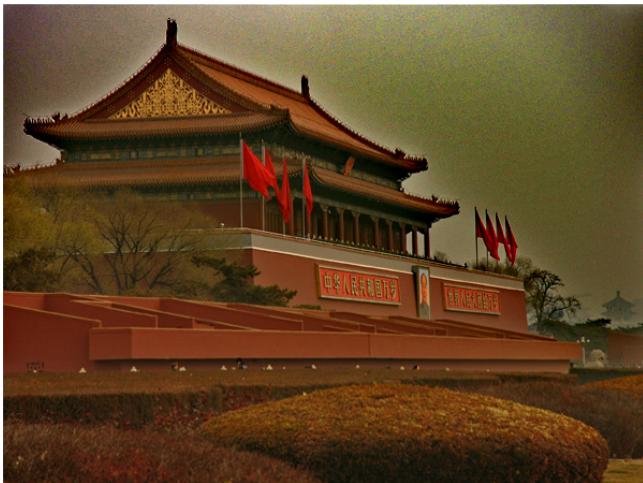
Fig. 6. Visual comparisons for real image dehazing. The results generated by He *et al.* [1] and Meng *et al.* [2] have hue distortions as shown in Fig. 6(b) and Fig. 6(c) (see the sky regions). DehazeNet [3] and Ren *et al.* [4]'s results contain haze in the buildings areas as shown in Fig. 6(d) and Fig. 6(e). In contrast, our result is visually better than others.



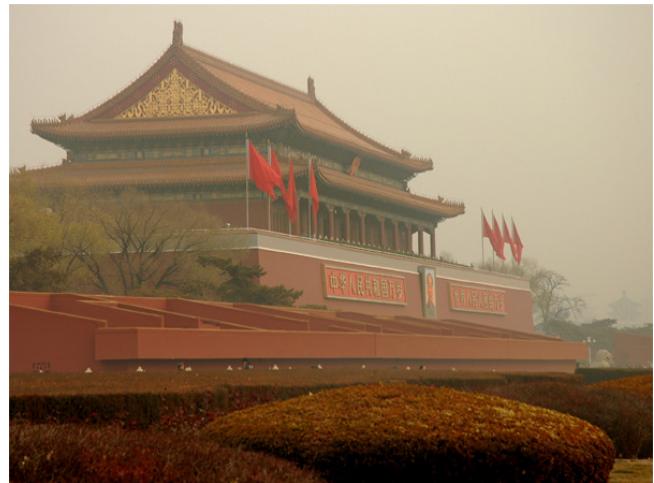
(a) hazy image



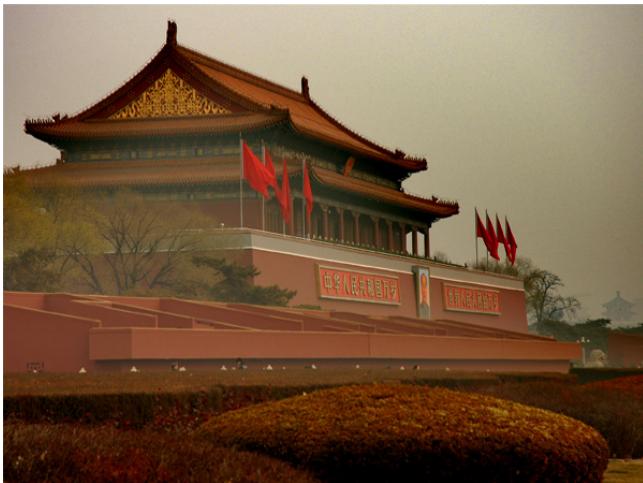
(b) He *et al.* [1]



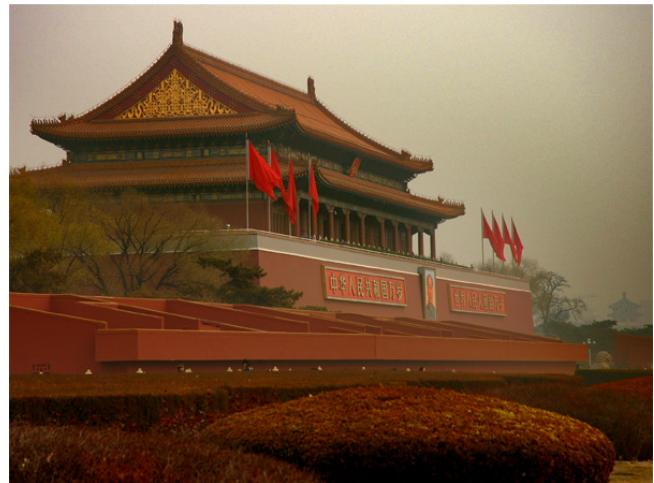
(c) Meng *et al.* [2]



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 7. Visual comparisons for real image dehazing. The results generated by He *et al.* [1], Meng *et al.* [2] have hue distortions as shown in Fig. 7(b), Fig. 7(c) (see the sky regions). DehazeNet [3] and Ren *et al.* [4]'s results still contain haze as shown in Fig. 7(d) and 7(e).



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 8. Visual comparisons for real image dehazing. Our dehazed image in Fig. 8(f) consists of clearer scene than other results (see the advertising boards).



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 9. Visual comparisons for real image dehazing.



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 10. Visual comparisons for real image dehazing.



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 11. Visual comparisons for real image dehazing.



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]

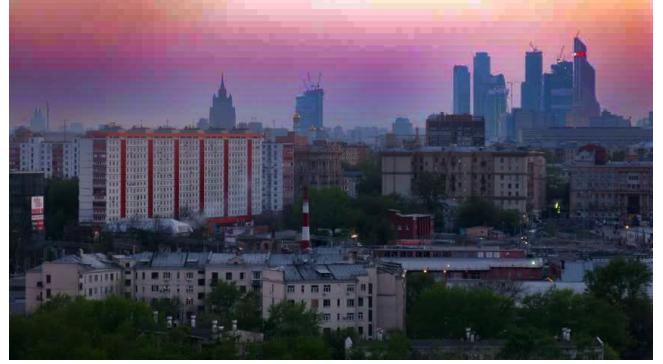


(f) Our result

Fig. 12. Visual comparisons for real image dehazing.



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 13. Visual comparisons for real image dehazing. The result recovered by He *et al.* [1] and Meng *et al.* [2] have obvious color distortions and halo artifacts in sky region in Fig. 13(b) and Fig. 13(c). DehazeNet [3] and Ren *et al.* [4]'s methods tend to over-saturated images (see the trees in Fig. 13(d) and the sky region in Fig. 13(e)).



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]

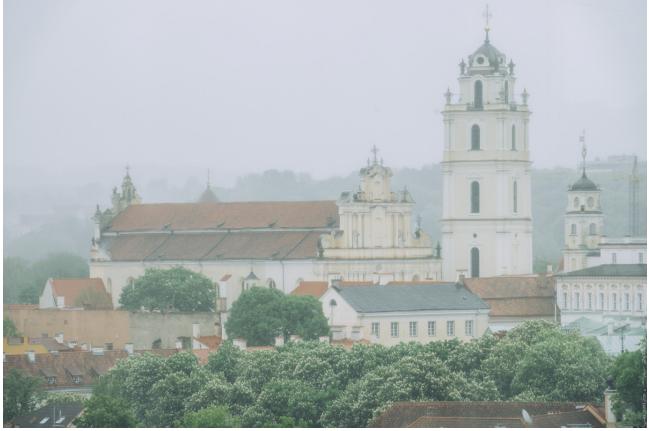


(e) Ren *et al.* [4]



(f) Our result

Fig. 14. Visual comparisons for real image dehazing. The results generated by He *et al.* [1], Meng *et al.* [2] have over-saturated regions as shown in Fig. 14(b) and Fig. 14(c) (see the sky and buildings). DehazeNet [3]'s result contains some haze as shown in Fig. 14(d).



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

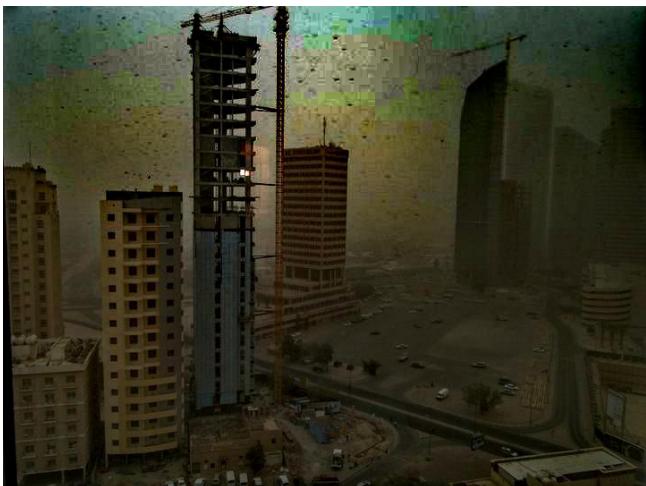
Fig. 15. Visual comparisons for real image dehazing. The results generated by He *et al.* [1], Meng *et al.* [2] and Ren *et al.* [4] have over-saturated regions as shown in Fig. 15(b), Fig. 15(c) and Fig. 15(e) (see the sky and buildings). DehazeNet [3]'s result contains some haze in the red rectangle region as shown in Fig. 15(d). In contrast, our result is visually sharper and clearer than others.



(a) hazy image



(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 16. Visual comparisons for real image dehazing. The dehazing methods by He *et al.* [1] and Meng *et al.* [2] become darker than others. DehazeNet [3]'s result still contain obvious haze in Fig. 16(d).



(a) hazy image



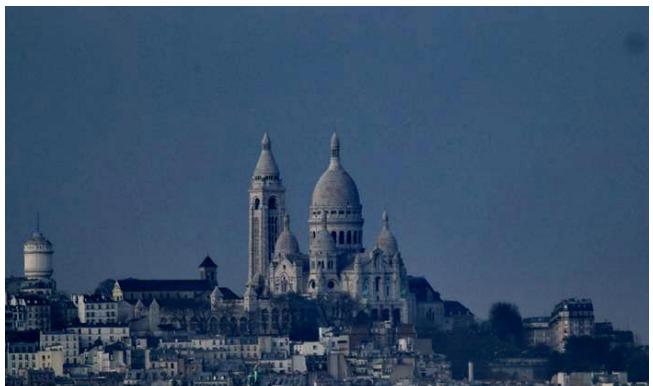
(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 17. Visual comparisons for real image dehazing. The dehazed results, including He *et al.* [1], Meng *et al.* [2] and Ren *et al.* [4], all have color distortions. DehazeNet [3]'s result still contain haze in Fig. 17(d).



(a) hazy image



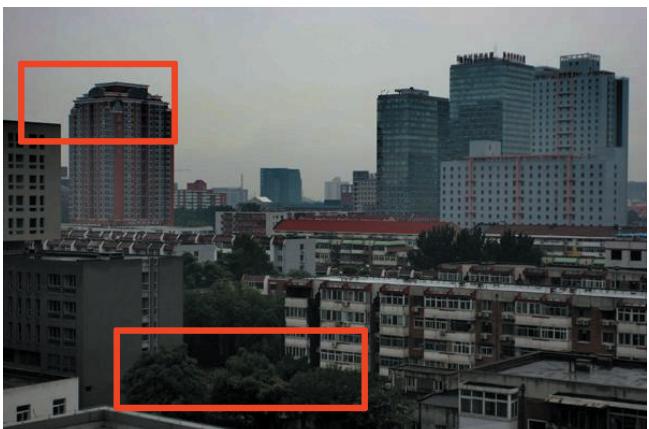
(b) He *et al.* [1]



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



(d) DehazeNet [3]



(e) Ren *et al.* [4]



(f) Our result

Fig. 18. Visual comparisons for real image dehazing. The dehazing methods by [1] and Meng *et al.* [2] have obvious color distortions in the sky regions (see Fig. 18(b) and Fig. 18(c)). In addition, the results recovered by [3], [4] are over-saturated images (see the red rectangles in Fig. 18(d) and Fig. 18(e)).



(a) hazy image



(b) He et al. [1]



(c) Meng et al. [2]



(d) DehazeNet [3]



(e) Ren et al. [4]



(f) Our result

Fig. 19. Visual comparisons for real image dehazing. Note that the result recovered by Ren et al. [4] still contains some haze in Fig. 19(e).

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