Spatially-Varying Blur Detection Based on Multiscale Fused and Sorted Transform Coefficients of Gradient Magnitudes

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1. Summary

We address the blur detection problem from a single image without requiring any knowledge about the blur type, level, or camera settings. Our approach computes blur detection maps based on a novel High-frequency multiscale Fusion and Sort Transform (HiFST) of gradient magnitudes.

2. Challenges and Contributions

Challenges:

- There are only few methods focusing on spatially-varying blur detection regardless of the blur type [1, 2, 3, 4, 5, 6], and the rest perform well only on defocus blur or motion blur.
- The performance of most of the existing methods degrades drastically when taking into account the effects of camera noise and distortion.

Contribution:

- We propose a robust spatially-varying blur detection method from a single image to determine the level of blur at each location in an image.
- We evaluate our proposed algorithm on both defocus and motion blur types to demonstrate the effectiveness of our method.
- We also test the robustness of our method by adding different levels of noise as well as different types and levels of distortions to the input image. We compare our method with state-of-the-art algorithms using their provided implementations and demonstrate that our proposed method outperforms existing state-of-the-art methods quantitatively and qualitatively.
- Finally, we provide a few applications of our method including camera focus points estimation, blur magnification, depth of field estimation, depth from focus, and deblurring.

3. Proposed Spatially-Varying Blur Detection

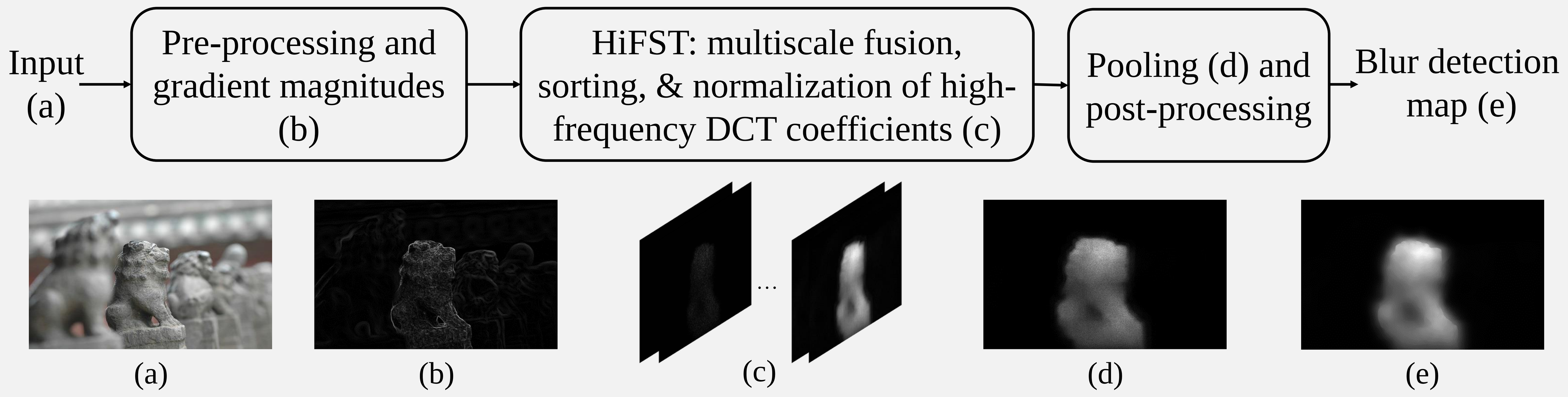

Fig. 1: Flowchart of our proposed blur detection algorithm along with example outputs for each stage.

Our proposed method is based on the fusion, sorting, and normalization of multiscale high-frequency DCT coefficients of gradient magnitudes to detect blurred and unblurred regions from a single image without having any information about the camera settings or the blur type.

4. Results

We evaluate the performance of our proposed method, HiFST, quantitatively and qualitatively. As shown in the paper, our proposed method outperforms the existing algorithms in terms of both quantitative and qualitative results regardless of the blur type. Moreover, we evaluate the robustness of our method to different types and levels of distortions.

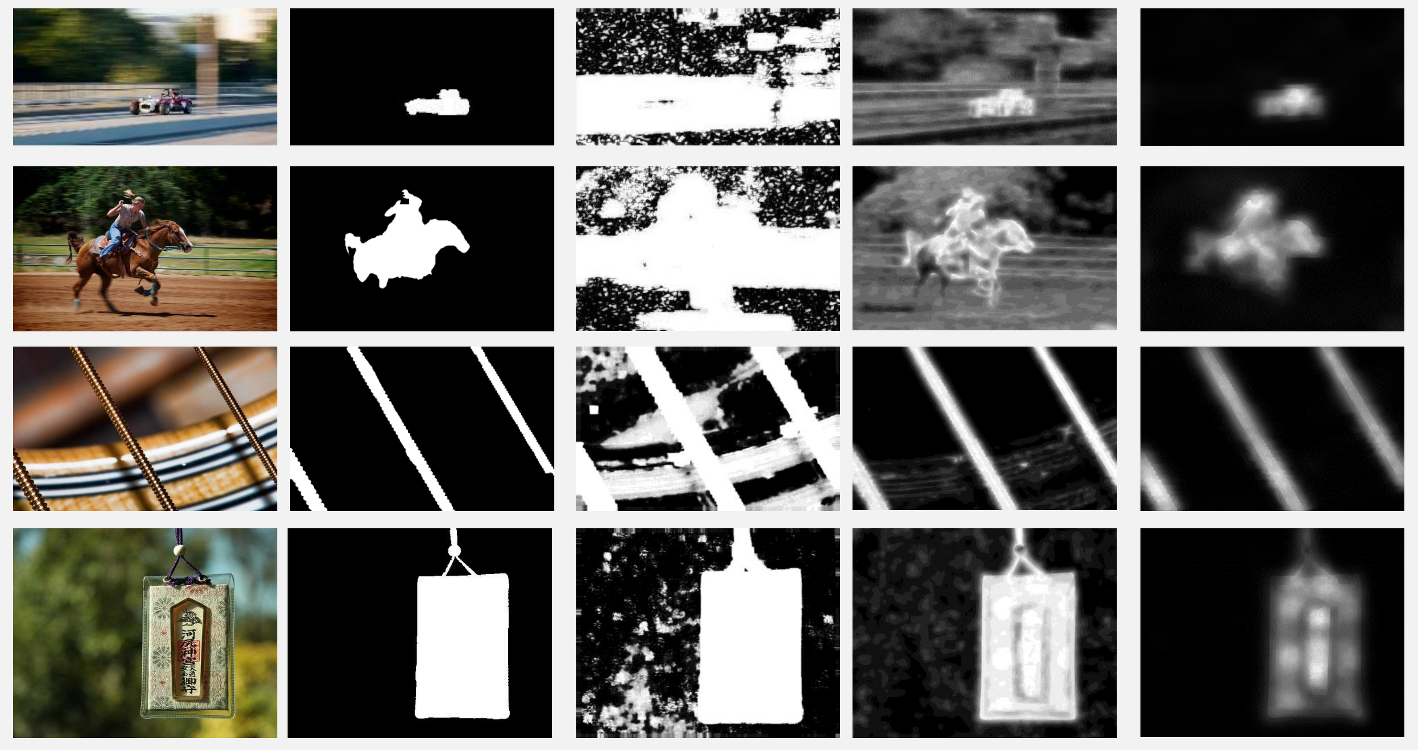

Fig. 2: Quantitative visual comparison

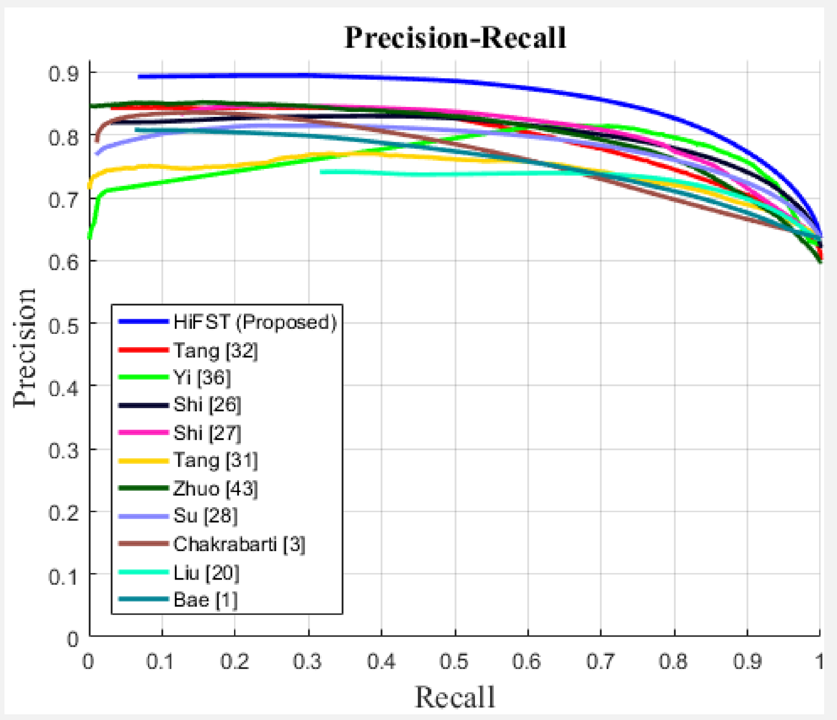

Fig. 3. Quantitative Precision-Recall comparison on the blur dataset [3] for different methods.

5. Applications

Depth of field estimation

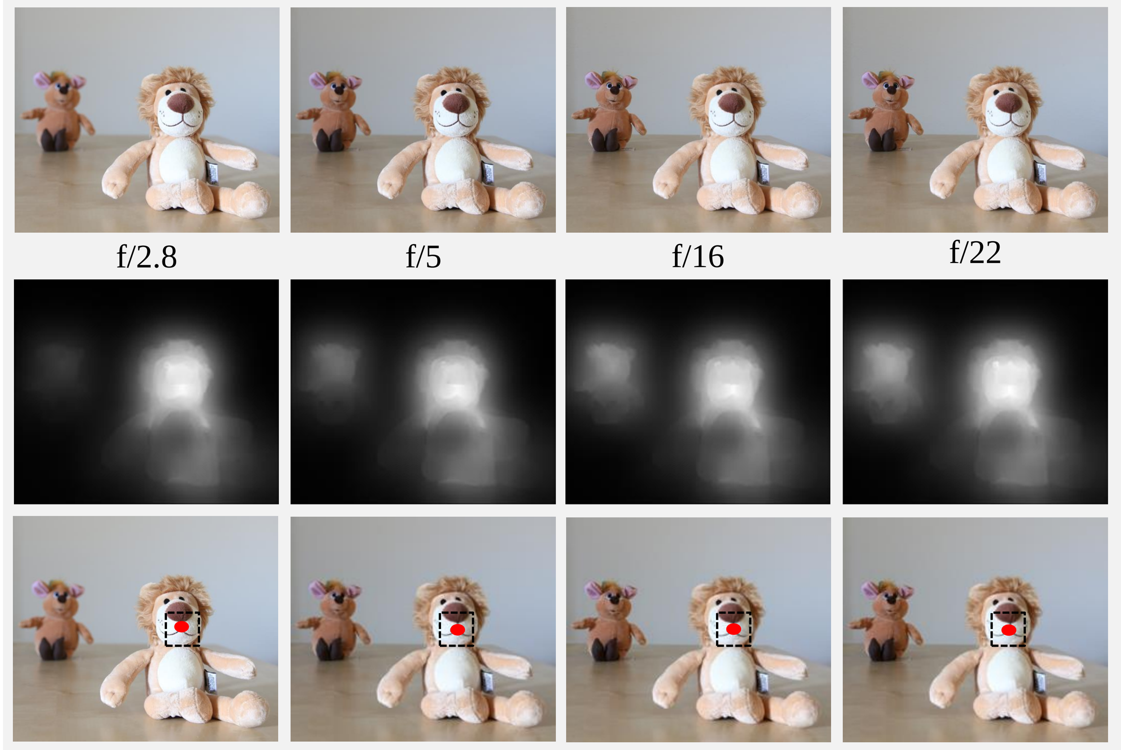

Fig. 4. Application of our proposed method in detecting blur for a photo taken under different aperture sizes in a dynamic setting. First row: input images. Second row: detected blur maps. Third row: estimated camera focus points.

Depth from focus

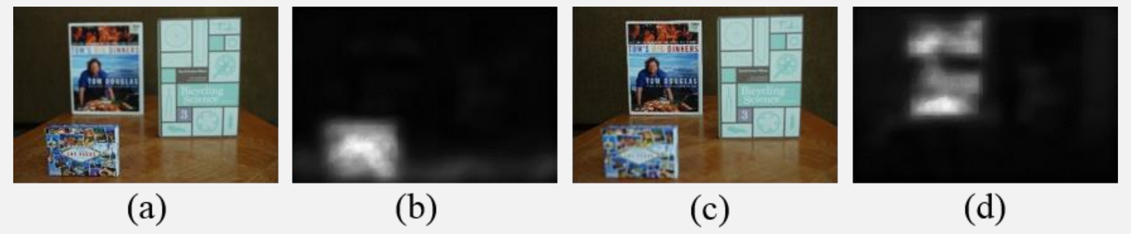

Fig. 5. Application of our method to changing the camera focus and DFF. (a) & (c) are images with different focus areas. (b) & (d) are our estimated maps.

Blur magnification

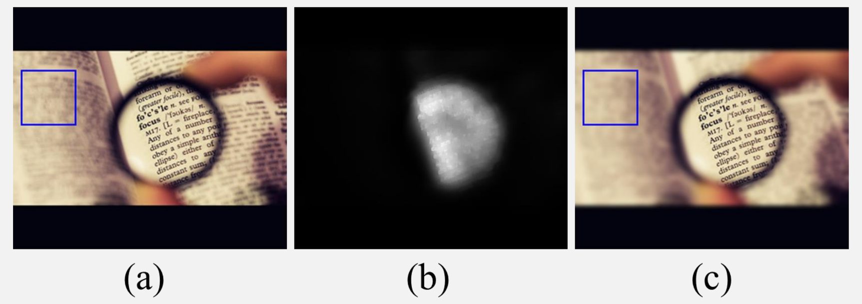

Fig. 6. Blur magnification. (a) Input image. (b) Our estimated blur map. (c) Results after blur magnification using our proposed blur map.

6. Conclusion

In this paper we addressed the challenging problem of blur detection from a single image without having any information about the blur type or the camera settings. Our algorithm achieves state-of-the-art results on blurred images with different blur types and blur levels. Furthermore, we showed that the proposed method can benefit different computer vision applications including camera focus points map estimation, blur magnification, depth of field estimation, depth from focus, and deblurring.

7. References

[1] Z. 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.

[2] 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.

[3] J. Shi, L. Xu, and J. Jia. Discriminative blur detection features. In IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pages 2965–2972, 2014.

[4] J. Shi, L. Xu, and J. Jia. Just noticeable defocus blur detection and estimation. In IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pages 657–665, 2015.

[5] B. Su, S. Lu, and C. L. Tan. Blurred image region detection and classification. In 19th ACM international conference on Multimedia, pages 1397–1400, 2011.

[6] C. Tang, J. Wu, Y. Hou, P. Wang, and W. Li. A spectral and spatial approach of coarse-to-fine blurred image region detection. IEEE Signal Processing Letters, 23(11):1652 – 1656, 2016.