Make Your Enemy Your Friend: Improving Image Rotation Angle Estimation with Harmonics: supplementary material

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Due to the page limitation of the letter, we provide more detailed results of the proposed method in this supplementary file.

1) Fig. 1, 2, and 3 provide more detailed results corresponding to the paper's figures 5, 6, and 7.

2) Table 1 compares different methods on images of various resolutions in terms of overall average estimation accuracy. The proposed method performs best for all interpolation kernels and all image sizes.

3) Fig. 4 illustrates the impact of the only hyper-parameter N_{har} of the proposed method. The rotated images are interpolated with the *nearest* kernel. N_{har} varies from 1 to 5. We also show the result of [1] in Fig. 4(a) for comparison. The proposed method performs steadily when $N_{har} \geq 2$. Hence, we adopt $N_{har} = 2$ in the paper for simplicity.

[1] C. Chen, J. Ni and Z. Shen, "Effective estimation of image rotation angle using spectral method," IEEE Signal Processing Letters, 21(7): 890–894, 2014.

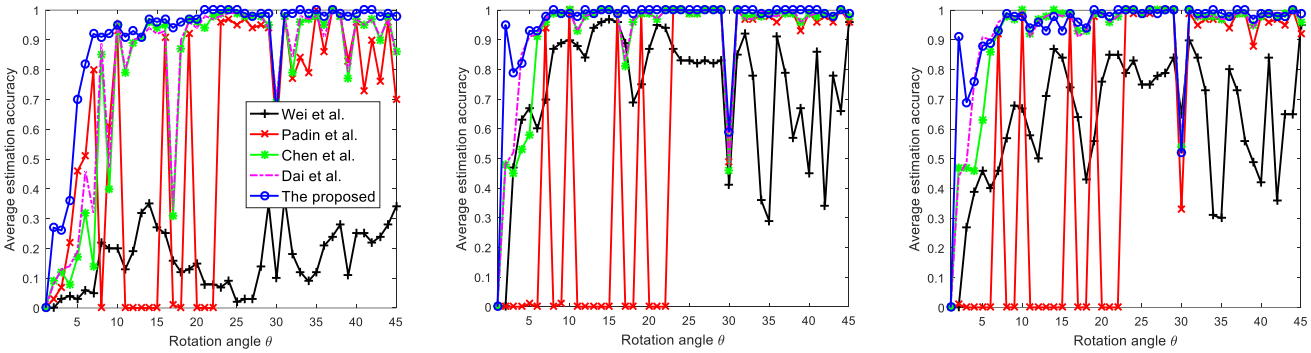

Fig. 1. Average estimation accuracy (%) over 500 uncompressed rotated images for different interpolation kernels. (a) *Nearest*, (b) *bilinear*, (c) *bicubic*. Fig. 1 (a), (b) and (c) share a legend for better visualization.

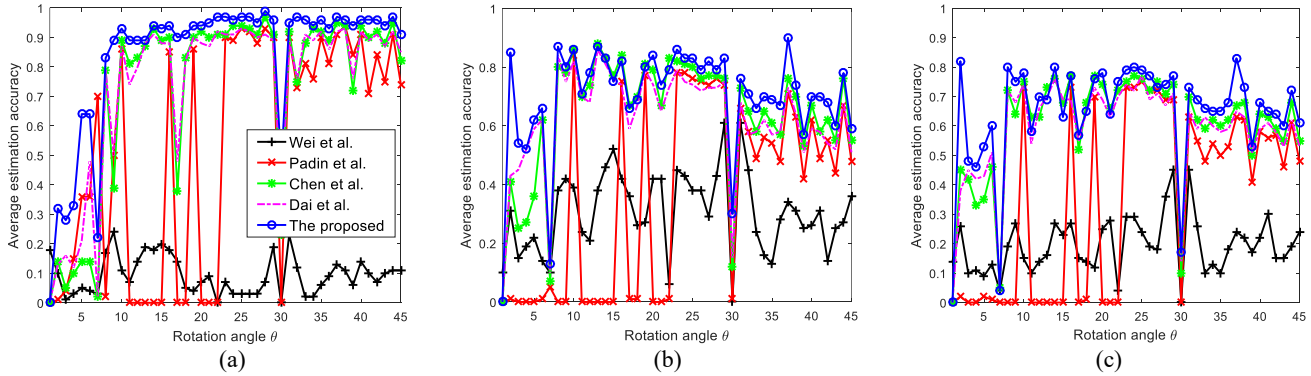

Fig. 2. Average estimation accuracy (%) over 500 JPEG compressed (QF=95) rotated images for different interpolation kernels. (a) *Nearest*, (b) *bilinear*, (c) *bicubic*.

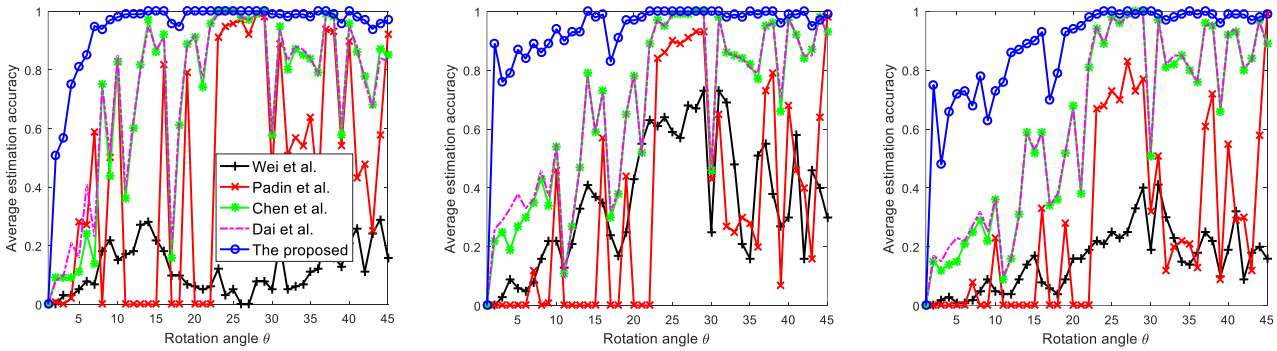

Fig. 3. Average estimation accuracy (%) over 500 images undergone scaling-then-rotation for different interpolation kernels. (a) *Nearest*, (b) *bilinear*, (c) *bicubic*.

Table 1. Overall average estimation accuracy (%) comparison. The best results are in **bold**.

Interpolation kernel	Image size	Wei	Padin	Chen	Dai	proposed
nearest	64 × 64	8.7	36.2	65.1	65.8	**75.2**
	128 × 128	16.0	57.3	78.1	79.4	**89.0**
	192 × 192	25.0	56.9	83.9	85.0	**92.2**
bilinear	64 × 64	59.2	39.5	78.5	79.0	**79.9**
	128 × 128	72.9	57.8	90.5	92.2	**95.2**
	192 × 192	77.3	57.4	93.3	95.8	**97.8**
bicubic	64 × 64	41.5	38.3	73.8	74.2	**74.6**
	128 × 128	62.1	56.9	90.3	91.6	**93.2**
	192 × 192	72.5	56.4	93.8	95.6	**95.9**

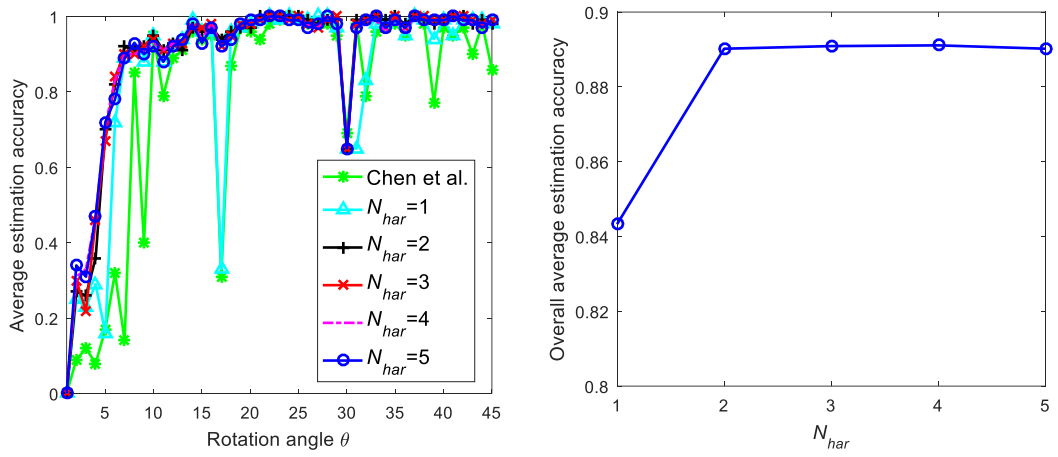

Fig. 4. The impact of N_{har} of the proposed method. The rotated images are interpolated with the *nearest* kernel. The image size is 128×128 pixels. (a) the estimation accuracy as a function of θ, (b) the overall average estimation accuracy.