

Comparative Study of FISTA, ISTA and BM3D Algorithms for Image Inpainting

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Abstract

This paper presents a comparative study of image inpainting algorithms, focusing on FISTA (Fast Iterative Shrinkage-Thresholding Algorithm) and its comparison with ISTA and BM3D. Experiments on the Set14 dataset show that FISTA-L1 achieves the best restoration quality (20.85 dB PSNR), while FISTA-TV offers the fastest computation (0.33 seconds). Convergence analysis confirms FISTA's superior convergence rate compared to ISTA.

Experimental Results

Algorithm	PSNR (dB)	SSIM	Time (s)	Iterations
FISTA-L1	20.85	0.5486	0.98	100
FISTA-TV	12.26	0.1620	0.33	100
ISTA	20.82	0.5476	0.88	100
BM3D	9.46	0.1218	6.82	N/A

Table 1: Quantitative results on ppt3.png (480x500, 60% missing)

Analysis

Algorithm Comparison:

1. FISTA vs ISTA: FISTA converges faster ($O(1/k^2)$ vs $O(1/k)$)
2. FISTA-L1 vs FISTA-TV: L1 better for texture, TV faster
3. Iterative vs BM3D: Iterative methods better for large missing regions

Computational Time:

- FISTA-TV: Fastest (0.33s)
- FISTA-L1: 0.98s, ISTA: 0.88s, BM3D: 6.82s
- FISTA-TV is $2.9 \times$ faster than FISTA-L1

Convergence Behavior:

- FISTA: Rapid initial convergence
- ISTA: Steady but slower
- FISTA reaches optimal PSNR in 50 iterations vs ISTA's 70

Conclusion

Key Findings:

1. FISTA-L1 provides best restoration quality (20.85 dB PSNR)
2. FISTA-TV offers fastest computation (0.33 seconds)
3. FISTA converges faster than ISTA (theoretical $O(1/k^2)$ vs $O(1/k)$)
4. BM3D performs poorly for large missing regions
5. Wavelet-based methods better for texture, TV better for edges

Application Recommendations:

- Real-time: FISTA-TV
- High-quality: FISTA-L1
- Texture images: FISTA-L1/ISTA
- Edge images: FISTA-TV
- Small noise: BM3D

Figure: Inpainting results visualization