Mid Sem Report
Project - 14 Super Resolution Problem

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***Abstract*—This interim report describes work completed so far on using classical interpolation methods for image super-resolution. We created a small custom dataset of high-resolution images, downscaled them to low resolution, and then upscaled the low-resolution images using nearest-neighbor, bilinear, and bicubic interpolation. Image similarity to the original high-resolution images was measured using PSNR and SSIM. For our dataset, bilinear produced marginally higher average PSNR and SSIM than bicubic, although visual differences are small. Next steps include applying classical enhancement filters and more detailed analysis.**

***Index Terms*—Super-resolution, interpolation, bicubic, bilinear, nearest neighbor, PSNR, SSIM**

I. Introduction

Super-resolution is the process of producing a larger, higher-detail image from a smaller one. In this project we focus on **classical** digital image processing techniques (no machine learning). The goal is to evaluate how well standard interpolation methods reconstruct an image, by comparing the upscaled image with the original high-resolution (HR) image using PSNR and SSIM.

For fair evaluation, LR–HR pairs were created by downscaling original HR images, which gives ground truth for comparison.

II. Methodology

A. Dataset Creation

- Custom dataset of HR images (from open-license sources or our own photos).
- HR images are 1024×1024. Each image downscaled by factor 4 (to 256×256) to produce LR images using OpenCV.

B. Super-resolution (Interpolation)

For each LR image we generated SR images (1024×1024) using OpenCV's `cv2.resize()` with:

- Nearest neighbor (`INTER_NEAREST`)
- Bilinear (`INTER_LINEAR`)
- Bicubic (`INTER_CUBIC`)

C. Evaluation Metrics

- **PSNR (Peak Signal-to-Noise Ratio):** Calculated from mean squared error between SR and HR. Higher PSNR means closer match.
- **SSIM (Structural Similarity Index):** Compares local patterns of pixel intensities (0–1, 1 = perfect match).

For each image and method, PSNR and SSIM were computed and averaged across all images.

III. Results

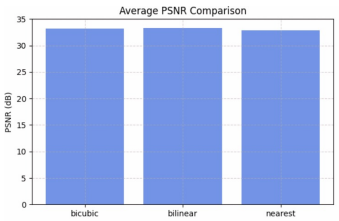
A. Quantitative Results

TABLE I: PSNR (dB) Comparison Table

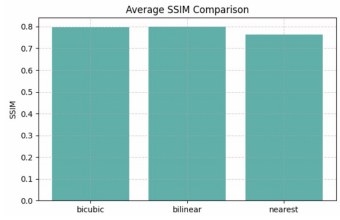
Image	Bicubic	Bilinear	Nearest
1 (1).jpg	31.18	31.36	30.90
1.jpg	39.68	39.70	38.01
10 (1).jpg	33.76	33.88	33.68
10.jpg	32.29	32.33	32.18
11 (1).jpg	32.28	32.31	31.58
11.jpg	30.91	31.03	30.91
19-200x200.jpg	28.75	28.73	28.62
2 (1).jpg	31.68	31.84	31.61
2.jpg	31.33	31.41	31.29
3 (1).jpg	34.01	34.18	33.70
3.jpg	38.19	38.45	38.30
4 (1).jpg	33.06	33.30	33.15
4.jpg	31.59	31.74	31.56
5 (1).jpg	34.02	34.26	33.48
5.jpg	32.19	32.43	32.15
6 (1).jpg	33.59	33.63	33.36
6.jpg	33.89	33.88	32.81
7 (1).jpg	34.07	34.35	33.61
7.jpg	31.84	32.05	31.84
8 (1).jpg	34.70	34.84	34.34
8.jpg	30.72	30.85	30.53
9 (1).jpg	35.75	36.02	35.51
9.jpg	34.20	34.37	33.88
Average	**33.20**	**33.35**	**32.91**

TABLE II: SSIM Comparison Table

Image	Bicubic	Bilinear	Nearest
1 (1).jpg	0.6913	0.6939	0.6506
1.jpg	0.9708	0.9715	0.9449
10 (1).jpg	0.8468	0.8517	0.8255
10.jpg	0.7769	0.7763	0.7520
11 (1).jpg	0.8385	0.8381	0.7630
11.jpg	0.7055	0.7081	0.6655
19-200x200.jpg	0.5876	0.5633	0.5258
2 (1).jpg	0.6949	0.7007	0.6759
2.jpg	0.6641	0.6724	0.6519
3 (1).jpg	0.8169	0.8241	0.7945
3.jpg	0.9390	0.9413	0.9345
4 (1).jpg	0.8091	0.8177	0.7870
4.jpg	0.7601	0.7651	0.7184
5 (1).jpg	0.8323	0.8410	0.7944
5.jpg	0.7546	0.7617	0.7241
6 (1).jpg	0.8800	0.8794	0.8436
6.jpg	0.8822	0.8823	0.8248
7 (1).jpg	0.8288	0.8413	0.7999
7.jpg	0.7465	0.7566	0.7169
8 (1).jpg	0.8748	0.8772	0.8517
8.jpg	0.6605	0.6588	0.6260
9 (1).jpg	0.8907	0.8979	0.8691
9.jpg	0.8864	0.8901	0.8457
Average	**0.7973**	**0.8005**	**0.7646**



(a) PSNR vs Methods



(b) SSIM vs Methods

Fig. 1: Comparison of interpolation methods using PSNR and SSIM.

B. Visual Examples

LR SR (Bilinear) HR

Fig. 2: Comparison of LR, SR (Bilinear), and HR images for sample 1.

Nearest Bilinear Bicubic

Fig. 3: Comparison of SR outputs using different interpolation methods for sample 1.

IV. Discussion

1) Bilinear shows a slight numeric advantage in PSNR/SSIM over bicubic; nearest is lowest.
2) Bicubic smoothing can reduce texture contrast slightly, affecting PSNR/SSIM.
3) PSNR/SSIM do not always match perceived visual quality.
4) Results depend on image content (edges, textures, noise).
5) Next steps: Apply enhancement filters (e.g., unsharp masking) to SR images and recompute metrics.

V. Conclusion

Classical interpolation methods were implemented on a custom HR–LR dataset. Bilinear showed slight numeric advantage, but bicubic often looks visually smoother. Future work includes enhancement filters and deeper analysis to evaluate when each method is preferable.

References

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