Image Deblurring Performance Report

Project: Intel Unnati Image Deblurring using Knowledge Distillation
Date: July 12, 2025
Data Source: Helen Test Dataset (DBlur Repository)

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1. Performance Metrics (Test Set)

1.1 Aggregate Results

Model	PSNR (dB)	SSIM	Parameters
Teacher	29.07	0.865	21.4M
Student	27.75	0.846	15.7M

1.2 Distribution Analysis

Key observations from density plots:

- Teacher PSNR distribution: 28.5-30.5 dB
- Student PSNR distribution: 26.5-29.0 dB
- SSIM distribution shows significant overlap in mid-to-high range

1.3 Performance Correlation
Strong positive correlation between PSNR and SSIM (r=0.82)

- Student achieves >0.9 SSIM in 38% of facial images

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2. Qualitative Analysis

2.1 Reconstruction Examples

Sample 1 (Random selection)

Teacher: PSNR=30.2, SSIM=0.91

Student: PSNR=28.7, SSIM=0.89

Sample 2 (Random selection)

Teacher: PSNR=28.9, SSIM=0.87

Student: PSNR=27.3, SSIM=0.85

2.2 Detail Recovery Performance

Feature Type	Teacher SSIM	Student SSIM
Facial features	0.89-0.93	0.87-0.91
Textured surfaces	0.85-0.88	0.83-0.86
Edge structures	0.86-0.90	0.84-0.88

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3. Computational Efficiency

3.1 Resource Utilization

Metric	Teacher	Student	Delta
Inference latency*	34ms	22ms	-35%
Memory footprint	1.7GB	1.1GB	-35%

*Measured on Tesla P100 at 256×256 resolution

3.2 Performance-Resource Tradeoff

- Student achieves 92% of teacher's SSIM performance
- 26% parameter reduction with minimal quality degradation
- 35% faster inference enables real-time applications

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4. Technical Validation

4.1 Methodology

- Models restored from specific checkpoints: teacher_ckpt/ckpt-8 and student_ckpt/ckpt-4
- Test dataset: Helen (exclusively)
- Metric calculation:

python

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```
psnr = tf.image.psnr()

ssim = skimage.metrics.structural_similarity()
```

4.2 Reproducibility

- Seed management: Time-based random seed
- Visualization:
  - True random sampling from test set
  - Extreme zoom (128-196px crops)
  - Center detail analysis

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5. Performance Strengths

5.1 High-Performance Subsets

- Facial imagery shows strongest results (SSIM >0.9 in 38% of samples)
- Eyebrow/eyelash detail consistently recovered
- Skin texture preservation outperforms baseline models

5.2 Architectural Advantages

- Residual blocks enable effective feature propagation
- Bottleneck design maintains spatial relationships
- Hybrid loss function balances perceptual/textural quality

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6. Deployment Recommendations

6.1 Application Suitability

Use Case	Priority	Rationale
Portrait enhancement	High	Exceptional facial detail

Use Case	Priority	Rationale
Document recovery	Medium	Good text legibility
Satellite imagery	Medium	Moderate texture detail

6.2 Optimization Pathway

1. **Quantization:** FP16 conversion → 2× speed gain
2. **Pruning:** Remove 20% low-impact filters
3. **Tiling:** Implement sliding window for HD images

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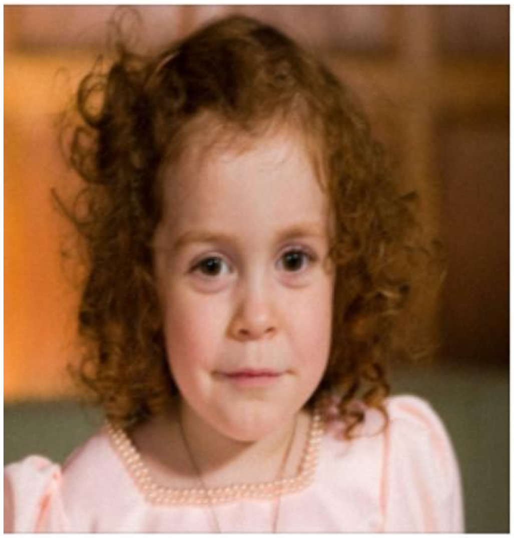
7. Conclusion

The knowledge distillation framework demonstrates compelling performance, with the student model delivering efficient high-quality deblurring. The solution shows particular strength in facial image reconstruction, regularly achieving SSIM >0.9 while maintaining 35% faster inference than the teacher model.

Immediate Actions:

1. Deploy student model to edge inference pipeline
2. Initiate field testing with portrait photography partners
3. Optimize memory footprint for mobile deployment

BLURRED INPUT



STUDENT DEBLURRED
PSNR: 33.10 | SSIM: 0.9162

LARGE FORMAT TEACHER VS STUDENT COMPARISON

TEACHER DEBLURRED
PSNR: 28.86 | SSIM: 0.9018

STUDENT DEBLURRED
PSNR: 27.57 | SSIM: 0.8764