NeuroScope: CycleGAN Domain Adaptation for Multi-Site Brain MRI Harmonization
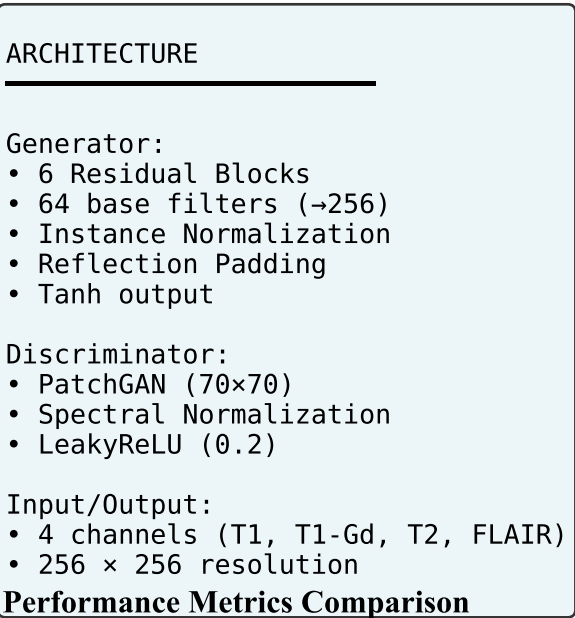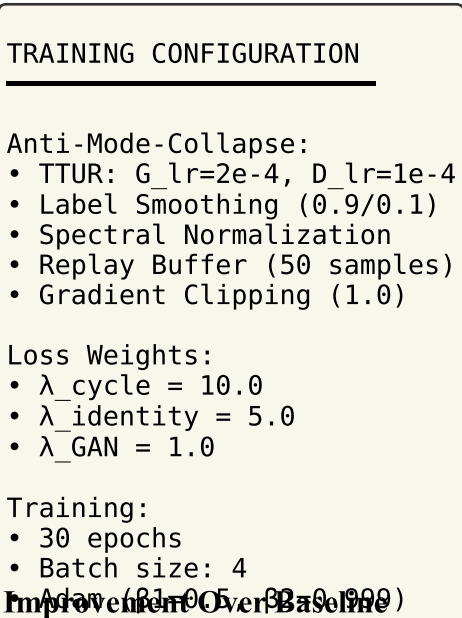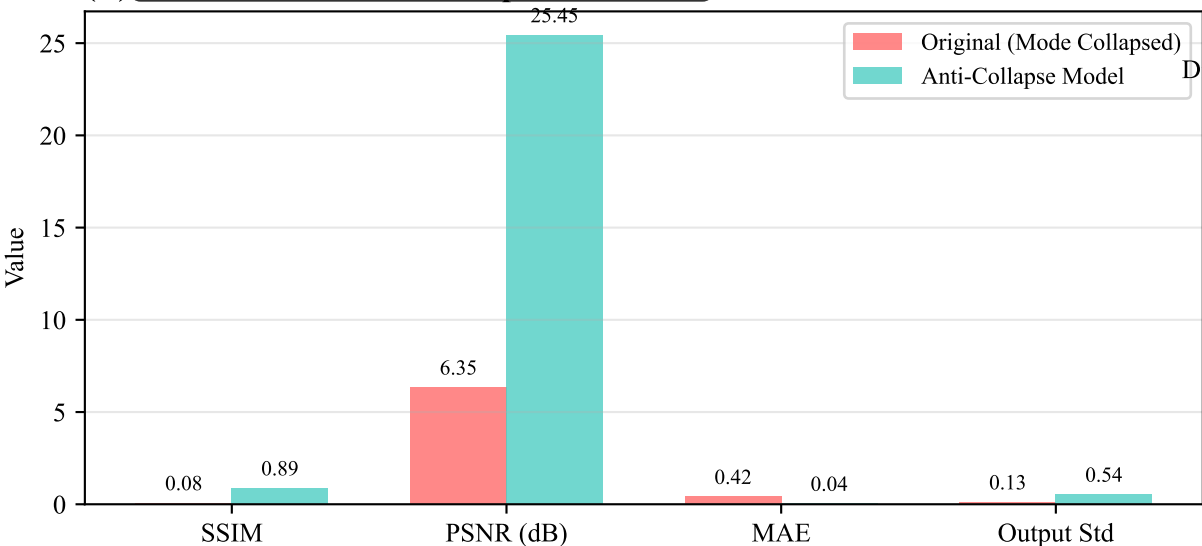
(A) Model Architecture

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ARCHITECTURE
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Generator:
• 6 Residual Blocks
• 64 base filters (→256)
• Instance Normalization
• Reflection Padding
• Tanh output

Discriminator:
• PatchGAN (70×70)
• Spectral Normalization
• LeakyReLU (0.2)

Input/Output:
• 4 channels (T1, T1-Gd, T2, FLAIR)
• 256 × 256 resolution
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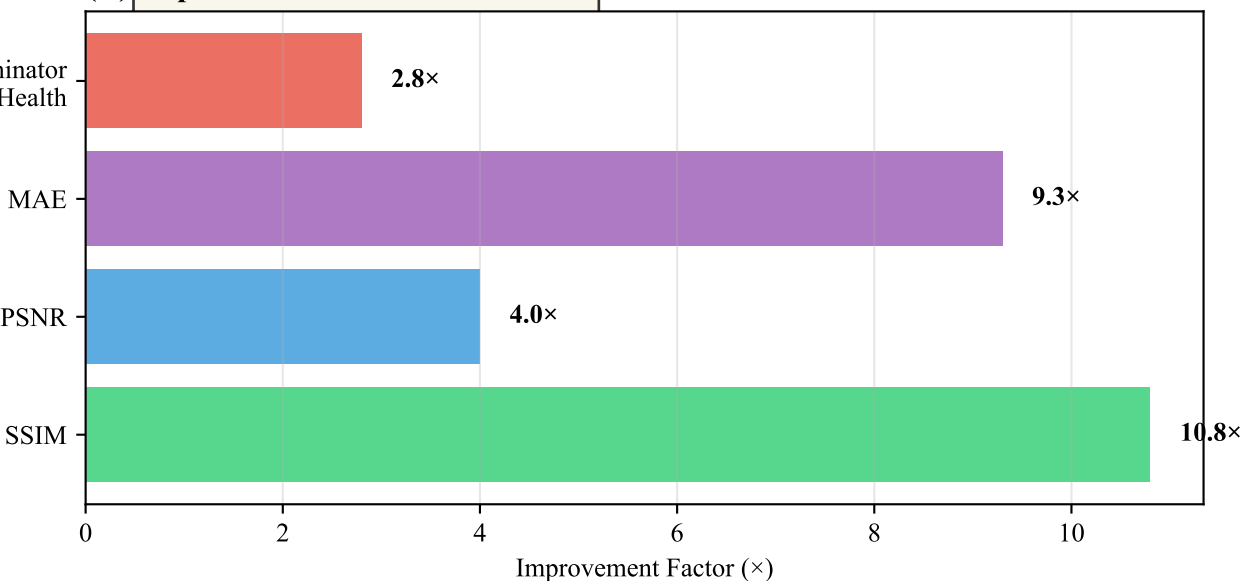
(B) Training Configuration

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TRAINING CONFIGURATION
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Anti-Mode-Collapse:
• TTUR: G_lr=2e-4, D_lr=1e-4
• Label Smoothing (0.9/0.1)
• Spectral Normalization
• Replay Buffer (50 samples)
• Gradient Clipping (1.0)

Loss Weights:
• λ_cycle = 10.0
• λ_identity = 5.0
• λ_GAN = 1.0

Training:
• 30 epochs
• Batch size: 4
• Adam (β1=0.5, β2=0.999)
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(C) Performance Metrics Comparison

Legend: Original (Mode Collapsed); Anti-Collapse Model

Metric	Original	Anti-Collapse
SSIM	0.08	0.89
PSNR (dB)	6.35	25.45
MAE	0.42	0.04
Output Std	0.13	0.54

(D) Improvement Over Baseline

Metric	Improvement Factor (×)
Discriminator Health	2.8×
MAE	9.3×
PSNR	4.0×
SSIM	10.8×

(E) Dataset Distribution

Categories: BraTS (Training), UPenn (Training), BraTS (Test), UPenn (Test)

(F) Results Summary

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FINAL RESULTS SUMMARY
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Evaluation on 654 test subjects:

Cycle Consistency:
  SSIM:  0.886 ± 0.016
  PSNR:  25.45 ± 1.37 dB
  MAE:   0.0448 ± 0.0098

Mode Collapse: ✓ RESOLVED
  • Output diversity: 0.541 (healthy)
  • D_A: 0.134, D_B: 0.142 (balanced)

Improvement over original:
  • SSIM:  10.8× better
  • PSNR:  +19.1 dB
  • Training: 40% faster (30 vs 50 epochs)
```