Improving the Progressive Denoising of MC Rendered Images in low SPPs

(From “Progressive Denoising of MC Rendered Images”, A. Firmino et al, EG 2022)

CS482 Final Project Presentation

Team 3
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Background: Noises in MC-Rendering @ low SPP

***16* Samples Per Pixel**

***1024* Samples Per Pixel**

Background: Denoising in MC-Rendering

***16* Samples Per Pixel**

16* Samples Per Pixel *Denoised

(By Intel OIDN)

Background: Denoisers do the things too much!

1024 Samples Per Pixel Denoised

1024 Samples Per Pixel

Problem: Existing deep-learning based denoisers for MCR

“Can produce smooth images using a low sample count”

How to overcome the problem?

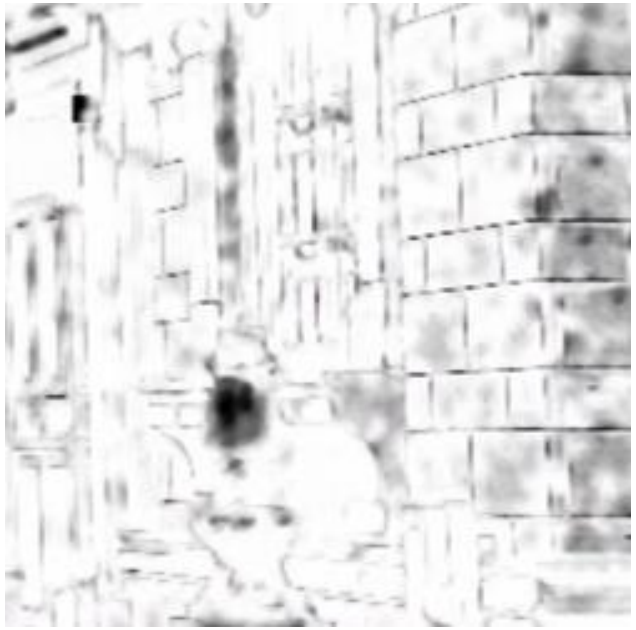
“Biased and do not converge to ground truth as SPP increase”

Recap: Progressive Denoising

- Blend denoised & original images based on variance of non-denoised pixels
- Produce optimal per-pixel mix parameter (which takes the best pixels of each image)

Input 1: Rendered

Input 2: Denoised



Per-pixel mixing param

Limitations : Progressive denoising

- **<u>Progressive denoising</u>** shows limitations at very low sample counts

Figure 13: *Limitation of our method at very low sample counts, 2spp in this example, arising from insufficiently accurate sample variance estimates.*

Motivation

"Improving progressive denoising at low SPPs"

Strengths

Apply denoising only when it's beneficial

Better Quality @ High SPPs

Our workarounds

Acceptable performance @ Low SPPs

"Consistent, versatile denoiser in all SPP ranges"

Approaches

<u>Adaptive Sampling based approach:</u>

- Can expect better quality in low SPPs
- Cannot guarantee if the implementation will be feasible

<u>Widening kernel based approach</u>

- Easy to implement
- Weak impact & cannot guarantee the quality

Approaches (1) : Mounting of Adaptive sampling

- **Adaptive Sampling:** Optimizing technique in MC rendering which allocates more samples to the areas of the suspicious part of the image

How to apply?

Un-denoised image with low SPP

Variance : 0!

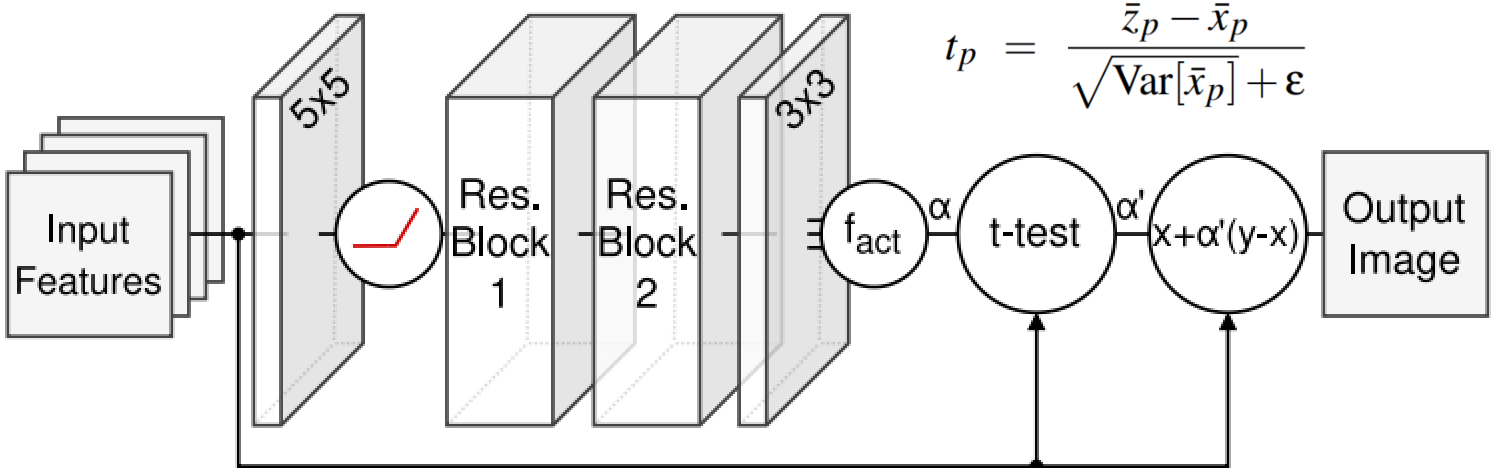
Pre-denoising step
If (variance too low):
More samples (~32)!

Variance: XX (>0)

Denoising decision

Approaches (1) : Mounting of Adaptive sampling

- **<u>Adaptive Sampling</u>** requires implementing another neural network for allocating extra samples on top of existing denoiser
- **<u>Intensive training time</u>**: > 10 hours of training each model with RTX 3090



Approaches (2) : Estimate from widen neighbourhood

- Original paper uses **11-by-11** size neighbourhood to estimate the radiance & variance of pixel
- Check if different kernel size options can give better results while it does not give performance degradance

Approaches (2) : Estimate from widen neighbourhood

GW: Glass-of-Water Scene (2 spp),
BR: Bathroom scene (2spp, High variance)

	Pro-den (11x11, paper)	**Pro-den (19x19, ours)**	**Pro-den (27x27, ours)**	**OIDN**	**MCR**
RMSE - GW	0.7832	**0.7689**	0.7867	0.7722	3.6853
RMSE - BR	1.2612	1.2566	1.2553	**1.2480**	9.2901
Training Time	14h 38m	15h 05m	15h 03m	-	-

Approaches (2) : Estimate from widen neighbourhood

Evaluation – comparison with Ground Truth / MC rendering

Ground Truth

Ours (2spp prog-denoised, 19*19)

Approaches (2) : Estimate from widen neighbourhood

Evaluation – comparison with Ground Truth / MC rendering

MC rendering (2 spp)

Ours (2spp prog-denoised, 19*19)

Approaches (2) : Estimate from widen neighbourhood

Evaluation – comparison with existing denoiser (OIDN)

OIDN

Ours (2spp prog-denoised, 19*19)

Conclusion

Main goal:

- Improving the quality of progressive denoising @ low sample counts
- Implementing the consistent, versatile denoiser at all SPP ranges.

Our approach:

- Applying adaptive sampling to progressive denoising
- Widening the kernel size for estimations

Results & Limitations

1. **Adaptive Sampling based approach takes too much time:**
   - If the training process takes this long, investigating methods for reducing the training time would also be a novel work
2. **Widening kernel size needs a good compromise**
   - Widening the kernel size for computing the radiance values is helpful depends on the scenes

Roles

Jaehyun Ha

- Coordinates the entire project
- Check if widening kernel-based approach works
- Check whether adaptive sampling methods can be applied on top of progressive denoising
- Making slides
- Review the literatures
- …

Thank You

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