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Institute of Computer Science

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Deblurring of microscopic 3D spheroid images using GANs

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Data

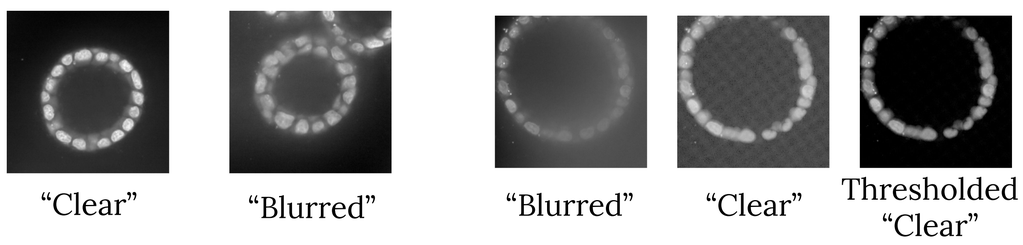

Figure 1. Datasets.

- 4 sequential stacks, 230 images each
- 31 spheroids

- 1 sequential stack, 300 image pairs
- Image pairs consist of raw and semi-manually corrected "Clear" images
- 7 spheroids

Models

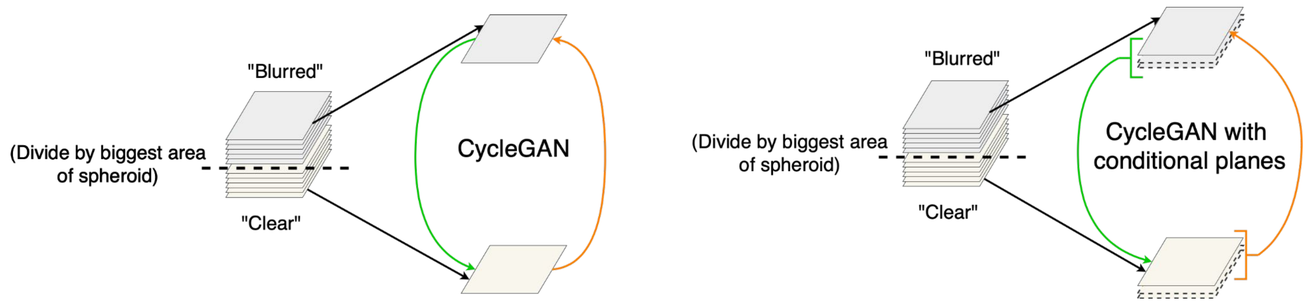

Figure 2. Training of unsupervised models. **Left:** Training of CycleGAN. **Right:** Training of CycleGAN with conditional planes.

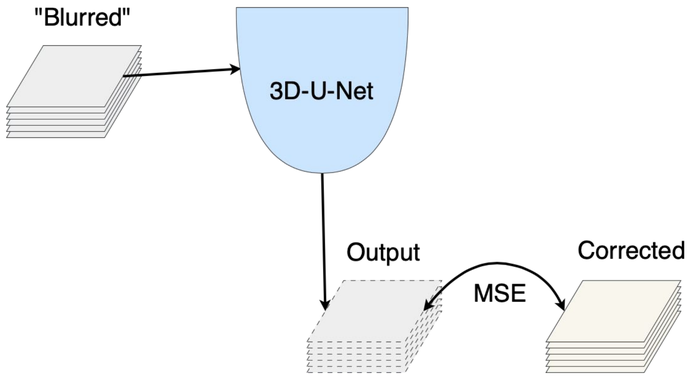

Figure 3. Training of supervised model.

Model setup:

- 3D convolutional layers instead of 2D
- Loss function — Mean Squared Error (MSE)
- Removed linear activation function
- Augmentations — random flipping and multiples of 90° rotation

Experiments

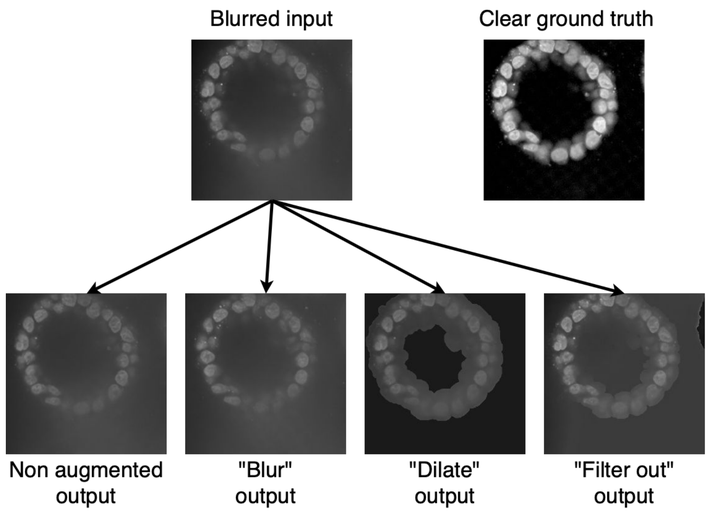

Figure 4. Visual results of best experiments using CycleGAN trained on data with different augmentations

Experiments with augmentations:

- "Filter out" — decrease the background intensity and remove adjacent spheroids
- "Blur" — apply heavy Gaussian blur on the nearby spheroids.
- Dilate — apply dilation morphology operation on segmentation mask and remove anything outside the mask.

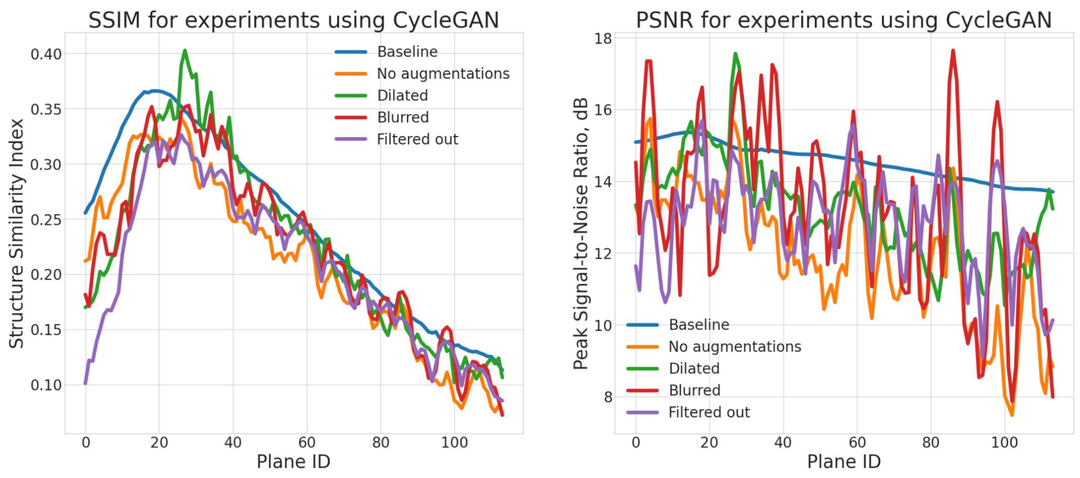

Figure 5. Measurements of best experiments using CycleGAN

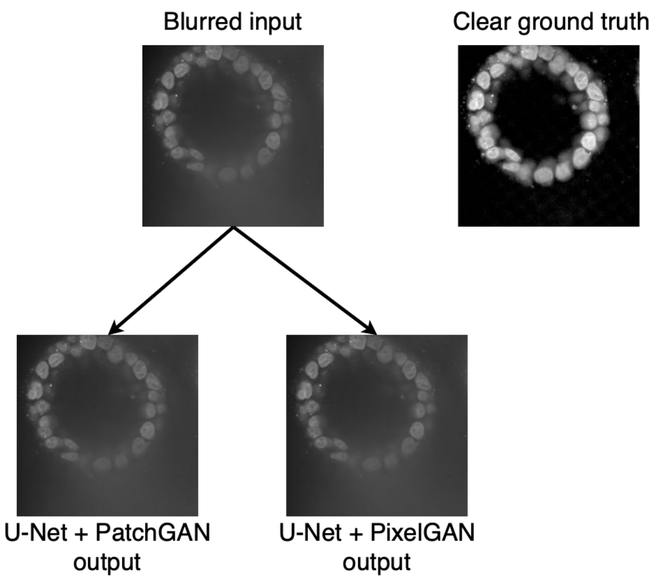

Figure 6. Visual results of best experiments using CycleGAN with conditional planes

Experiments with conditional planes:

- U-Net + PatchGAN — U-Net based generator, PatchGAN on 70x70 pixels discriminator
- U-Net + PixelGAN — U-Net based generator, PatchGAN on 1 pixel (PixelGAN) discriminator
- Both models use 1 conditional plane

Acknowledgements

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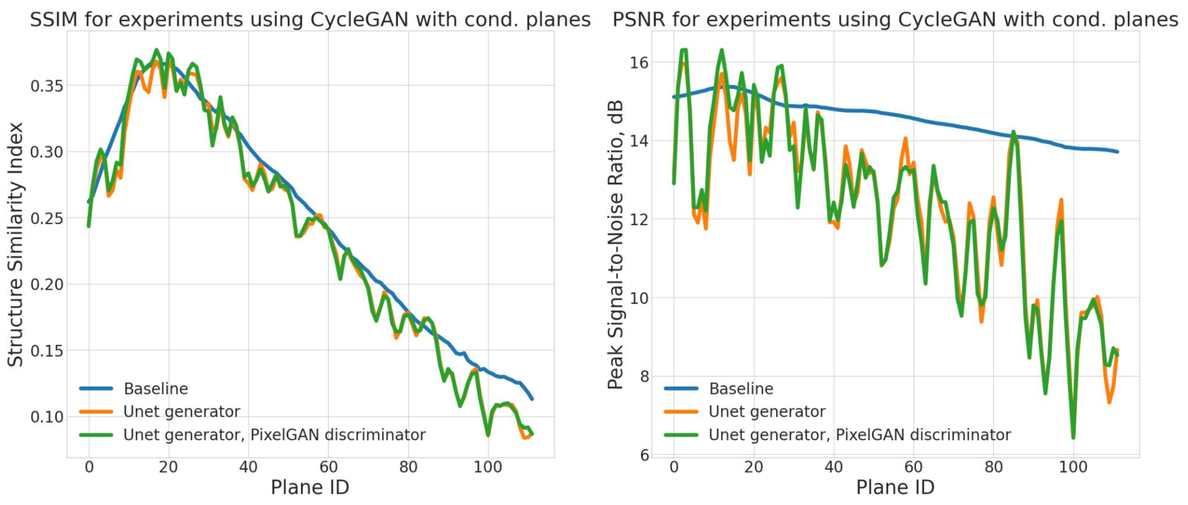
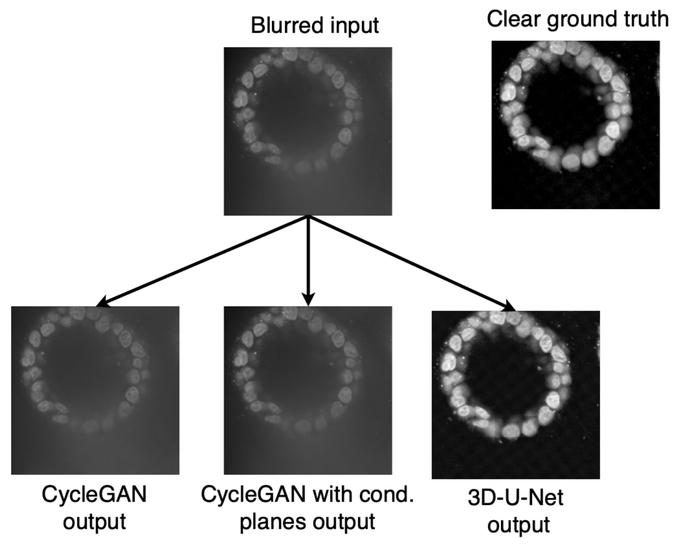


Figure 7. Measurements of best experiments using CycleGAN with conditional planes

Results



Best models:

- CycleGAN — model trained on non augmented images
- CycleGAN with conditional planes — model that uses U-Net+PixelGAN
- 3D-U-Net — model trained on 500 epochs

Figure 8. Comparison of visual results of best supervised and unsupervised models.

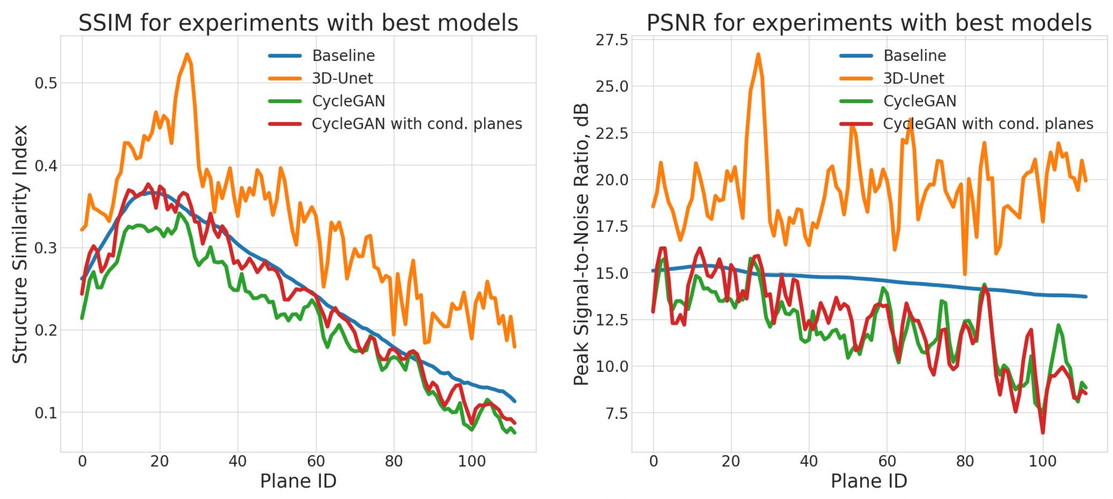


Figure 9. Comparison of measurements of best supervised and unsupervised models.

Key Takeaways

- Simpler model trained on a smaller supervised dataset can generate images better than a more complex framework trained on unsupervised data.
- The performance of the supervised model is limited due to the poor quality of the corrected images.