BronchoGAN: Anatomically consistent and domain-agnostic image-to-image translation for video bronchoscopy

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MOTIVATION

- Limited amount of public bronchoscopy videos is available for training deep learning models
- In contrast, large-scale public CT datasets do exist → can be used for GAN-based image synthesis
- Use anatomy from CT-rend... virtual bronchoscopy and ... phantoms as source domain
- Use appearance from limit... ex-vivo videos as target do...
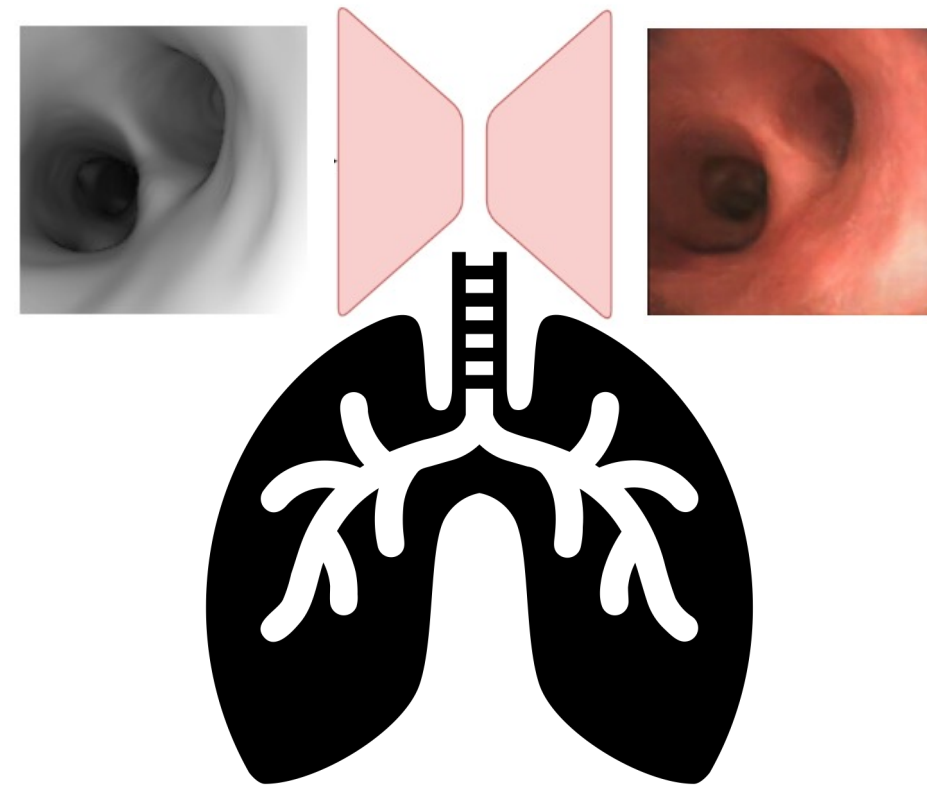
PROBLEM STA...

- GAN: Risk of mode collapse for ...
- Anatomy (bronchial orifice...
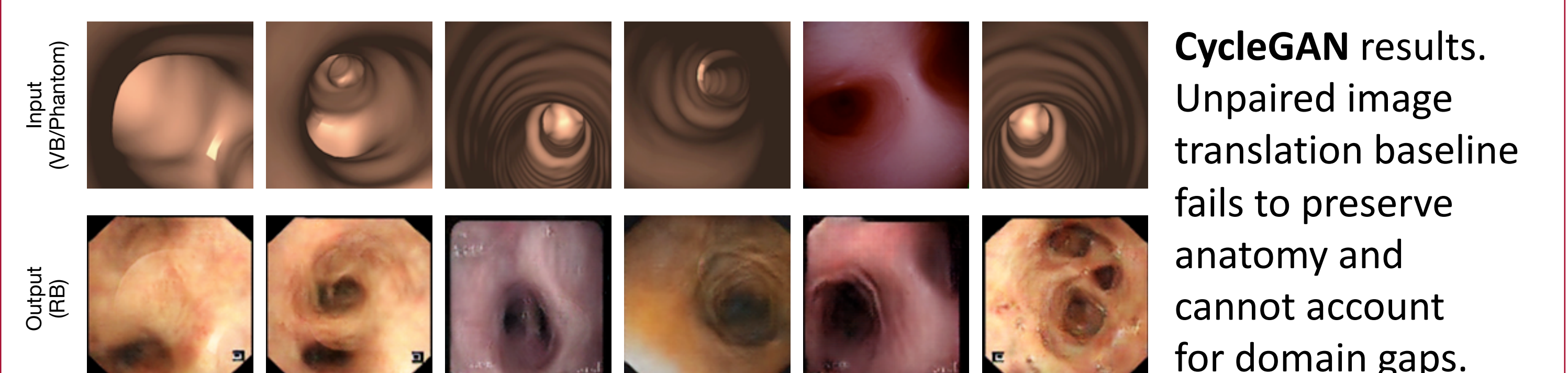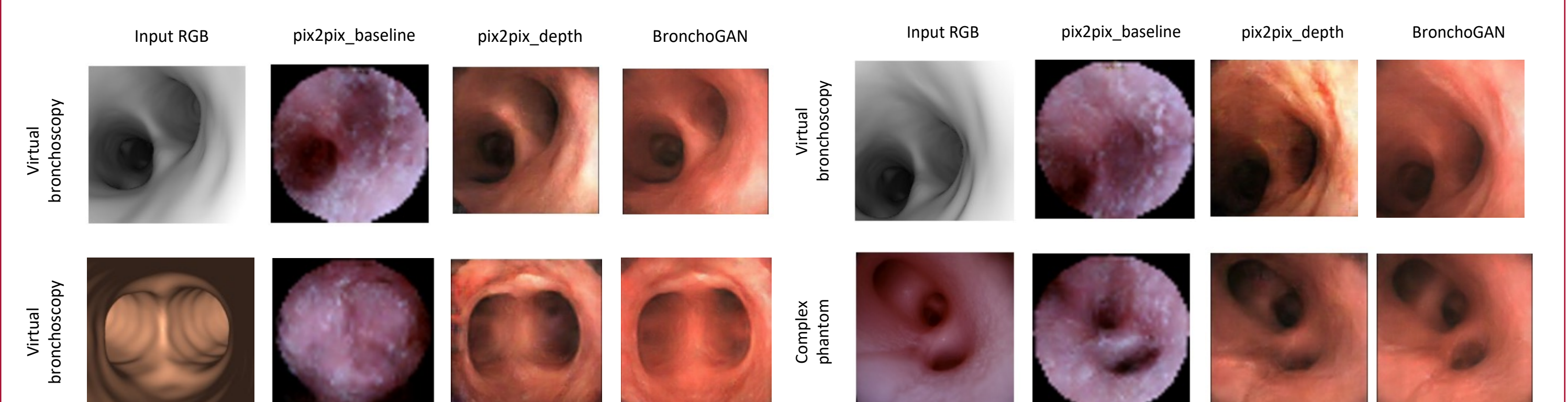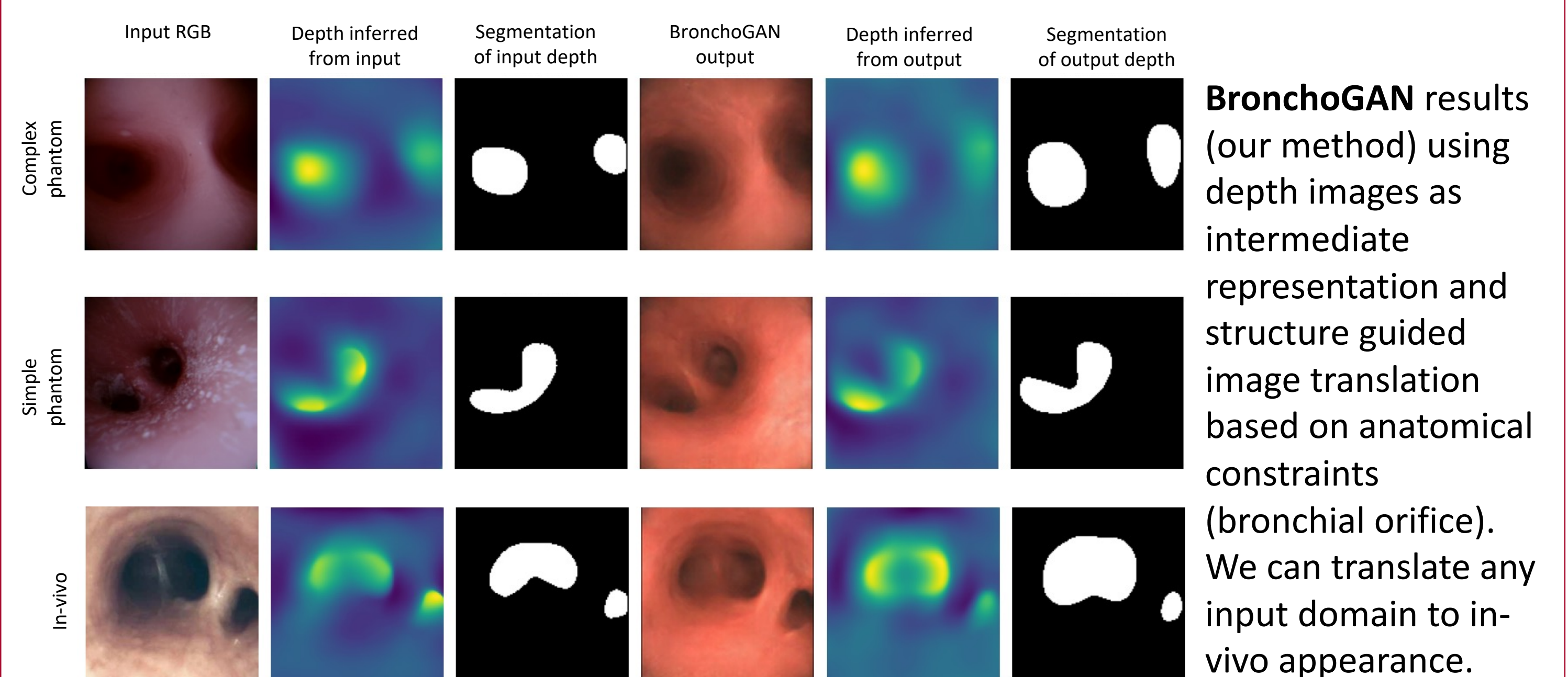- Different visual appearanc... phantom material/lightning) → domain gap

METHOD

- Use intermediate depth image representation obtained from foundational model (DepthAnything) → **Domain-agnostic representation**
- Segment anatomical structures (bronchial orifice) from depth images using training-free segmentation
- Condition image synthesis on segmentation maps of input and generator output → **Structure guidance using DICE loss**
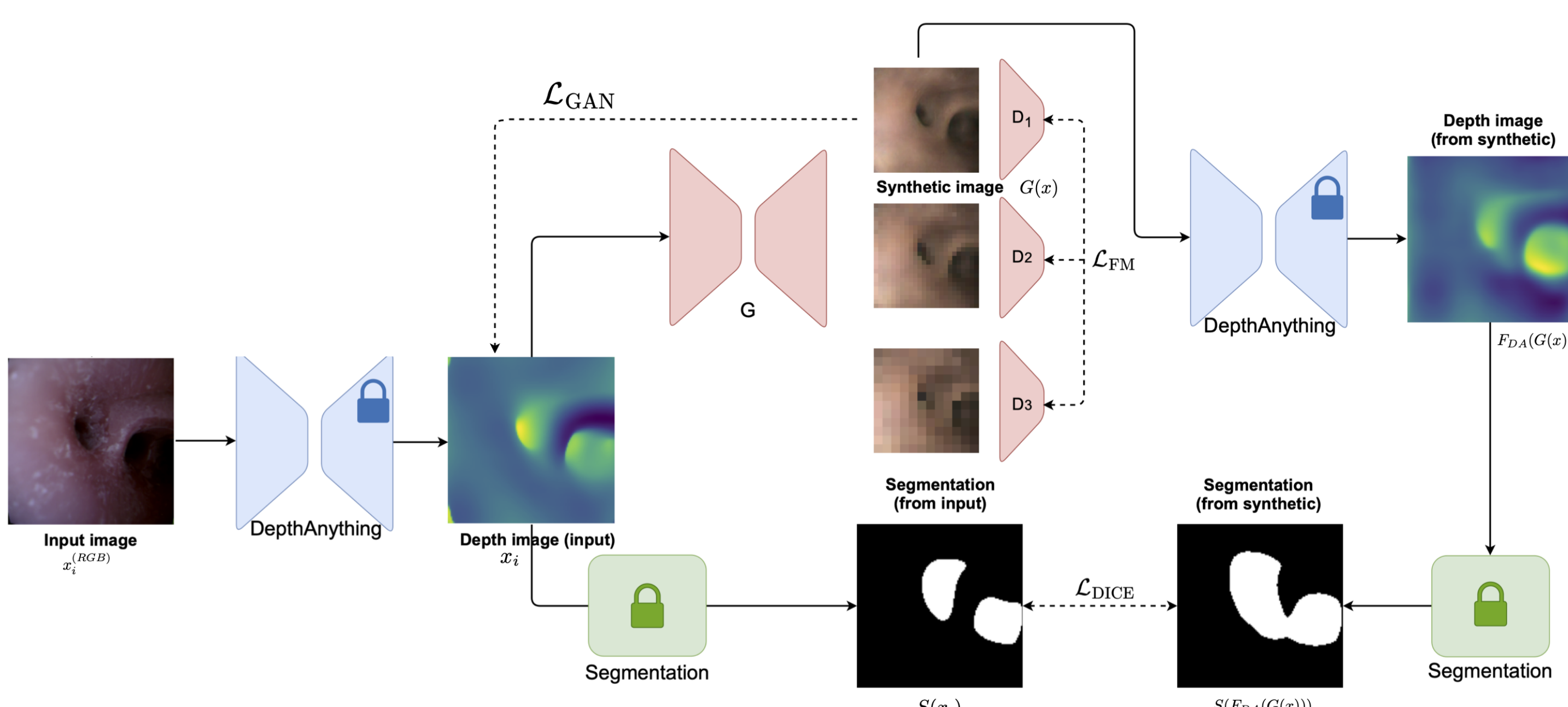
BronchoGAN architecture incorporating domain-agnostic image representations, training-free orifice segmentation and structure guidance.

BronchoGAN results (our method) using depth images as intermediate representation and structure guided image translation

...
We can translate any ...

CycleGAN results. Unpaired image translation baseline fails to preserve anatomy and cannot account for domain gaps.

QUANTITATIVE RESULTS

Model	FID ↓	SSIM ↑	DICE ↑
cycleGAN	1717.9574	0.2831	0.2412
pix2pix_base	1564.0430	0.4042	0.3950
pix2pix_depth (ours)	1006.5910	0.3875	0.6334
BronchoGAN (ours)	**770.6833**	**0.4623**	**0.6743**

CONCLUSION

- GAN-based image translation tends to mode collapse and faces domain gaps in bronchoscopy → use intermediate representation (depthAnything)
- Use segmentation maps to guide image synthesis and preserve anatomy (bronchial orifice)
- Future work addresses the integration of detailed labelling and multiclass segmentation