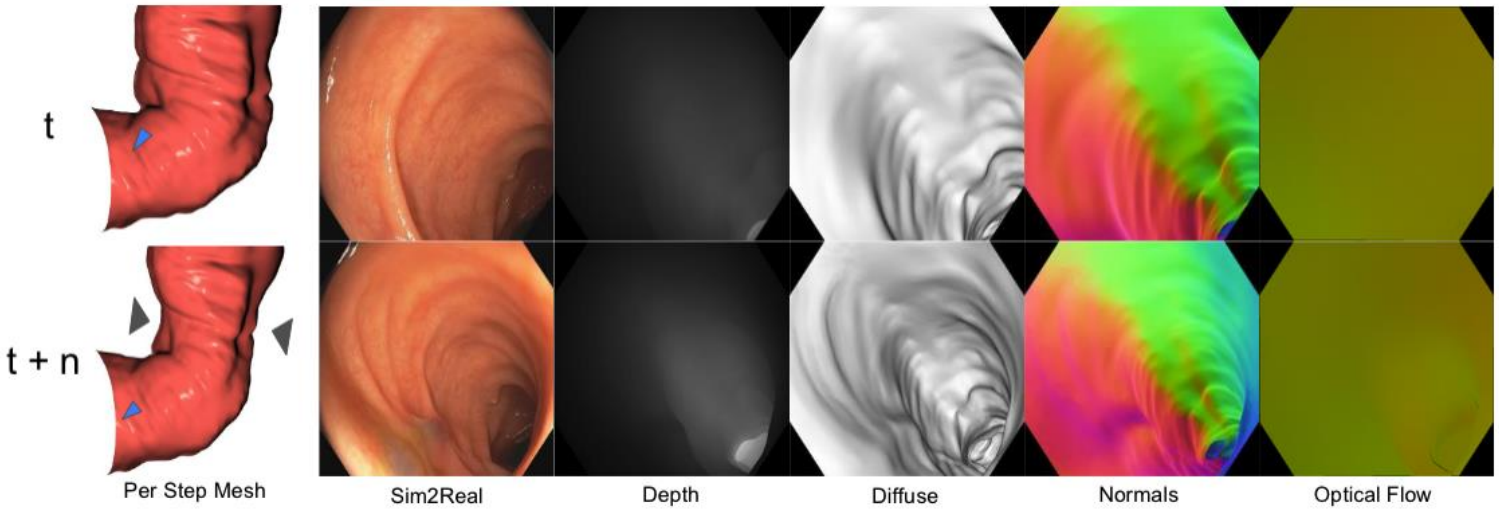
C3VD-DEFCOL: A Deformable Colonoscopy Dataset with Time-Resolved 3D Ground Truth and Realistic Appearance

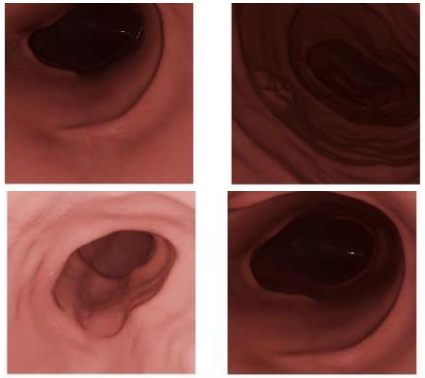
Ethan Luk* · Mayank Golhar* · Anthony Song · Raúl Iranzo · Victor M. Batlle · Lalithkumar Seenivasan · JMM Montiel · Nicholas Durr



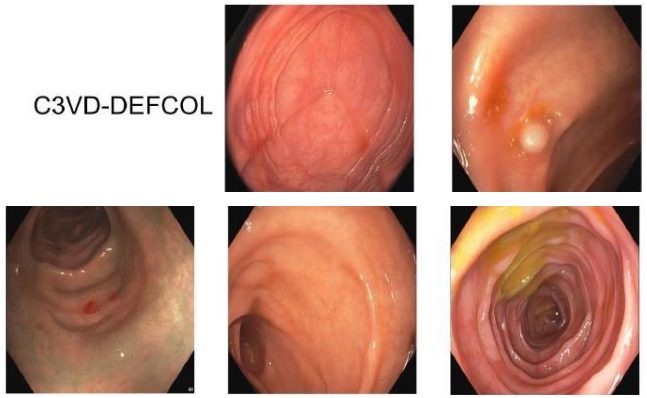
C3VD-DEFCOL motivation

C3VD-DEFCOL combines controlled deformation and per-time step ground truth with vivo–like appearance.

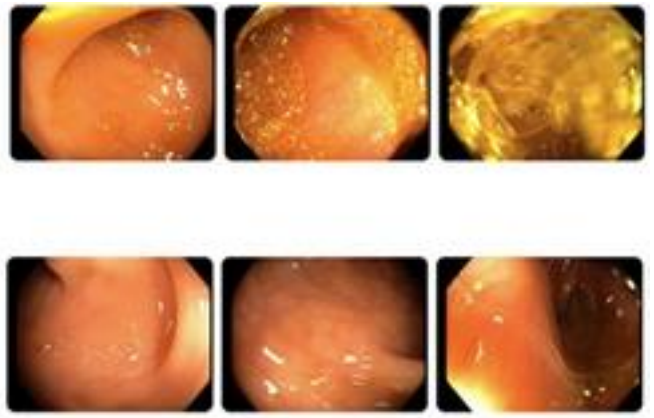
Rendered



Sim2Real



Real Colonoscopy



Realism ↓
Pixel Wise 3D GT ✓
Deformation ✓
(controllable)

Realism ✓
Pixel Wise 3D GT ↑
Deformation ✓
(controllable)

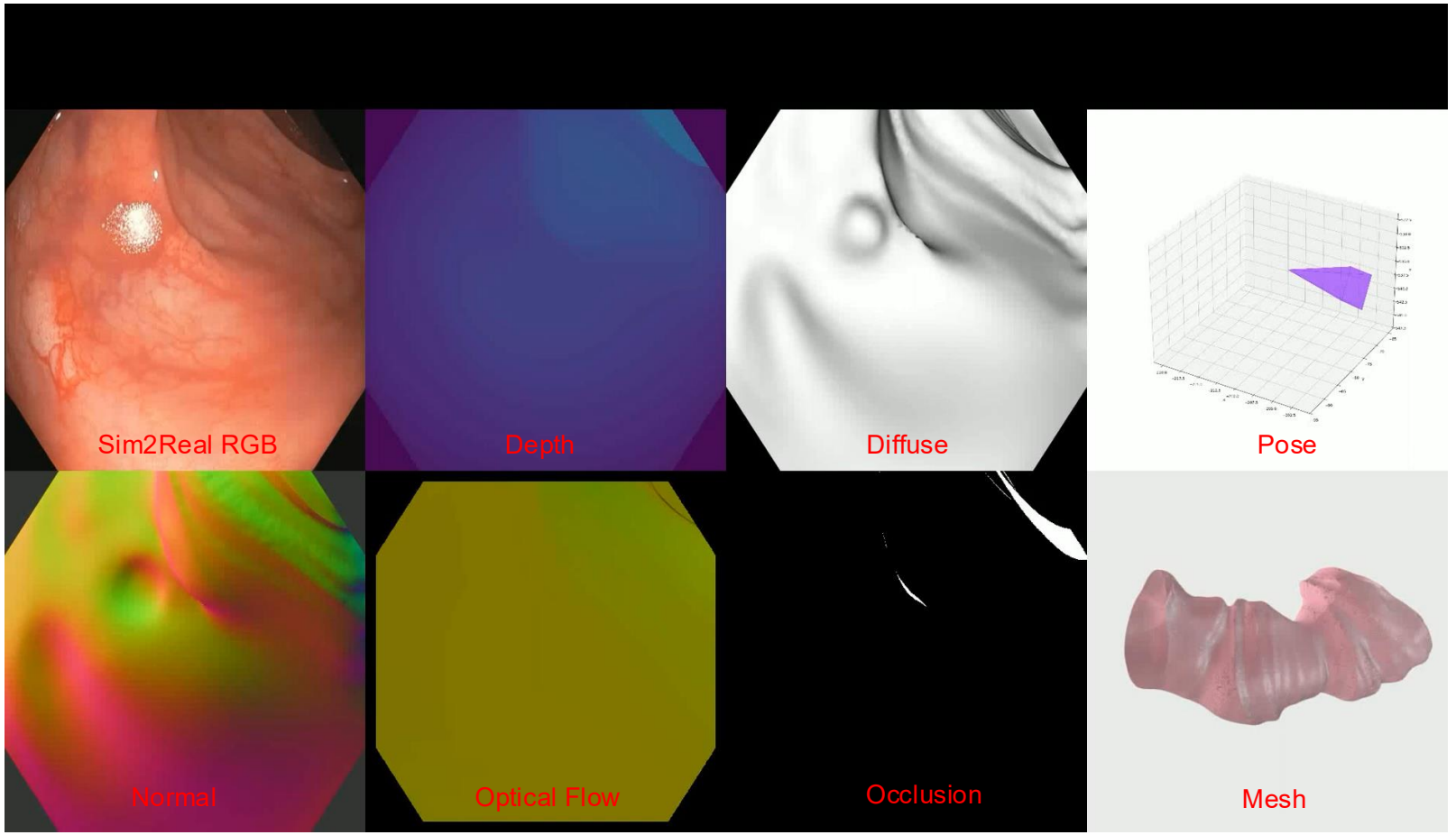
Realism ↑
Pixel Wise 3D GT ✗
Deformation ✓
(not controllable)



Smolak-DyĹĽewska, Weronika, et al. "ColonSplat: Reconstruction of peristaltic motion in colonoscopy with dynamic gaussian splatting." arXiv preprint arXiv:2603.06860 (2026)..
Azagra, Pablo, et al. "Endomapper dataset of complete calibrated endoscopy procedures." Scientific Data 10.1 (2023): 671.
Bobrow, Taylor L., et al. "Colonoscopy 3D video dataset with paired depth from 2D-3D registration." Medical image analysis 90 (2023): 102956.

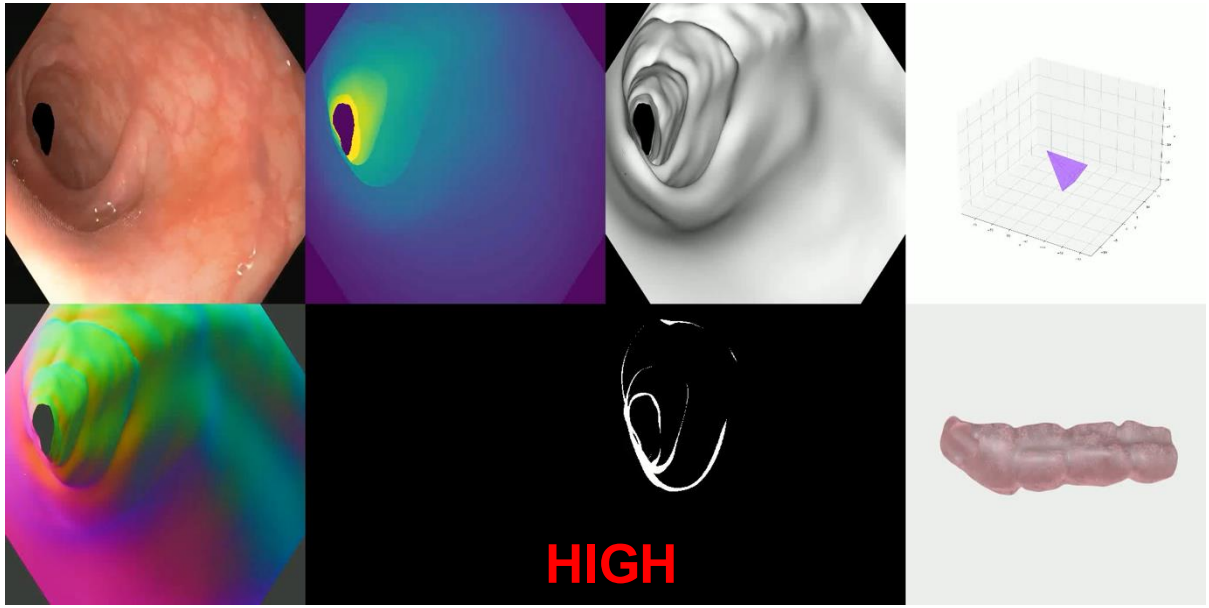
C3VD-DEFCOL Summary

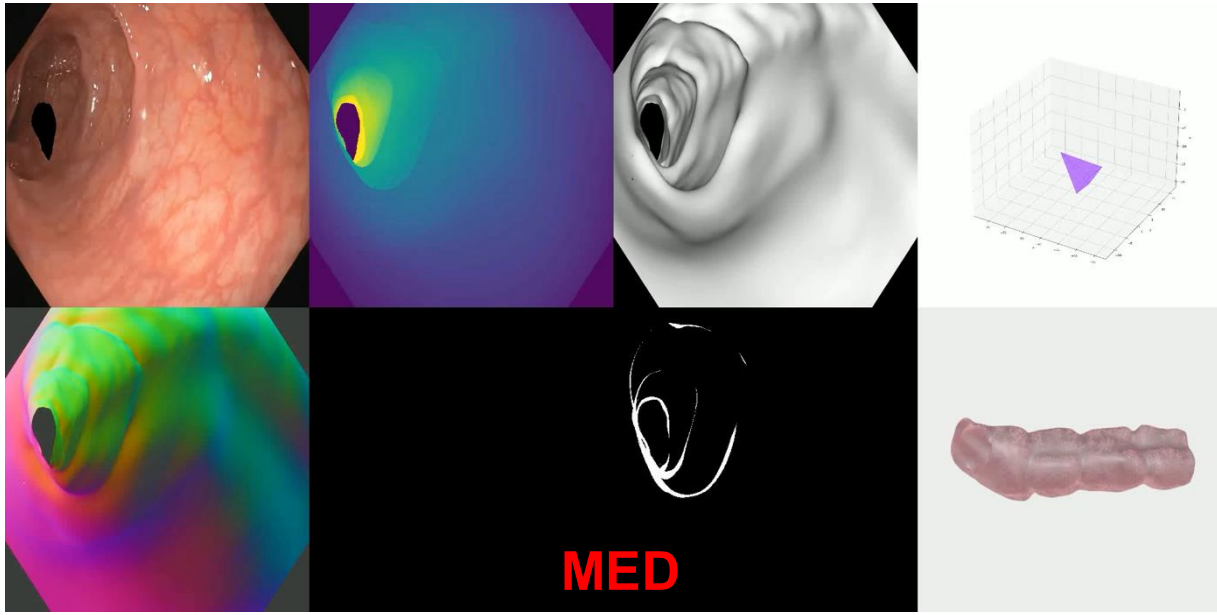
248 Videos, 19 colon segment geometries, 20,768 RGB frames

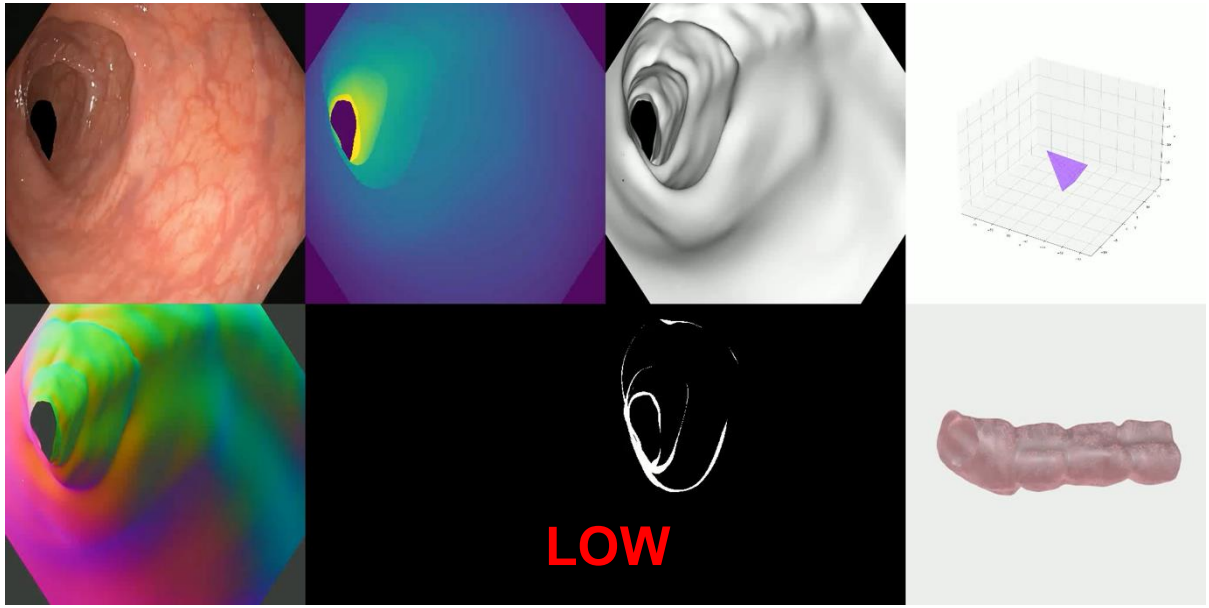


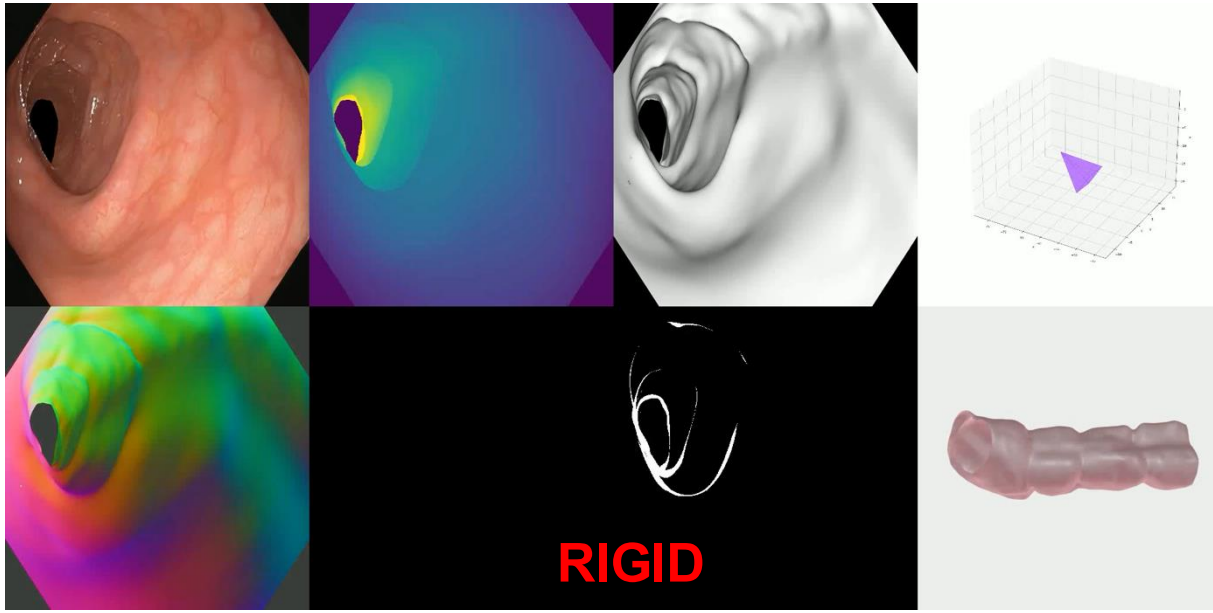
Please check the presentation for the video.

Same Anatomy, Diff. Deformation Levels





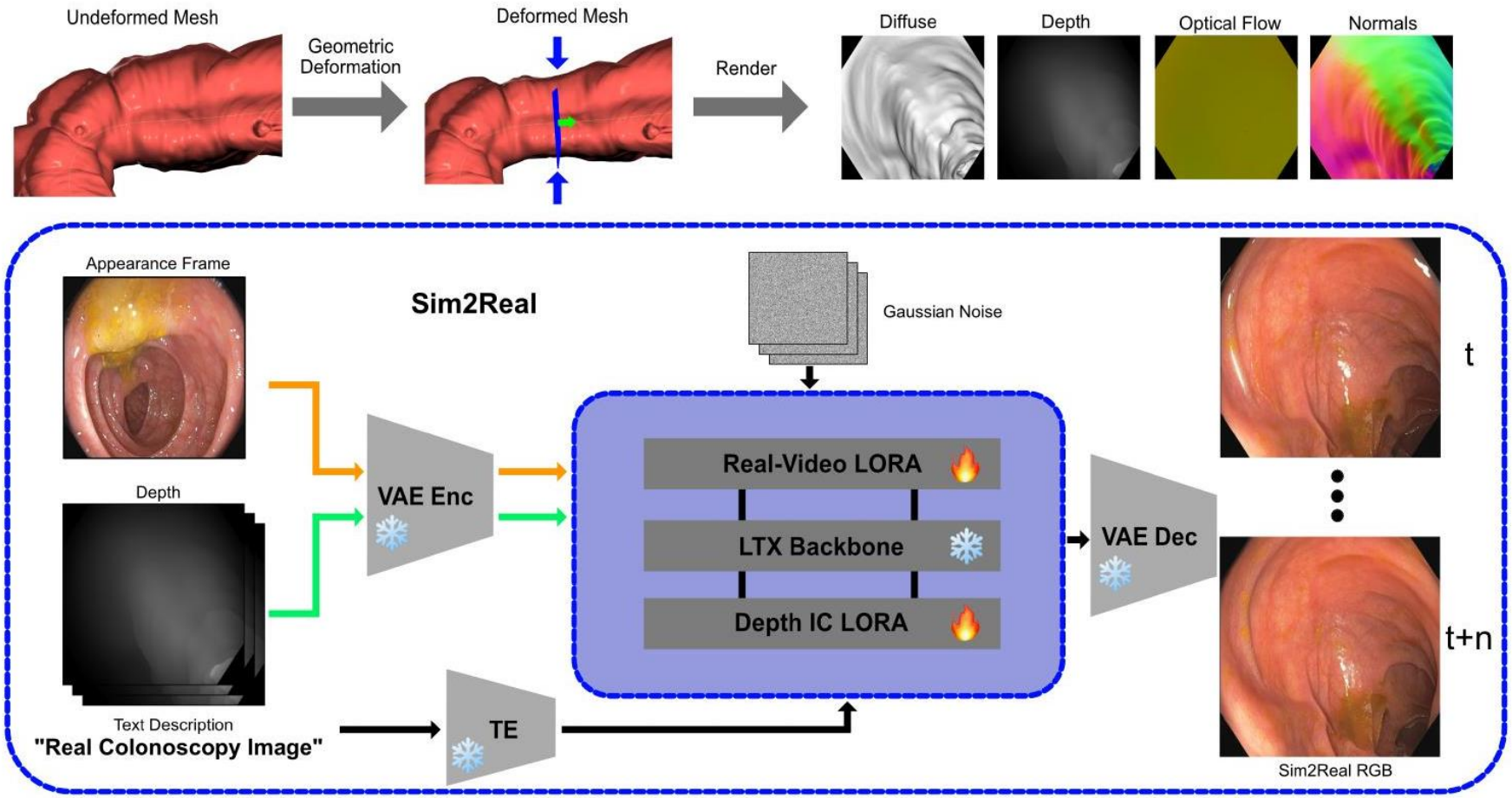




Data Generation Pipeline

2 – Step process: 1) Deform the colon mesh and render geometric maps.

2) Add colonoscopy color & texture using video diffusion model

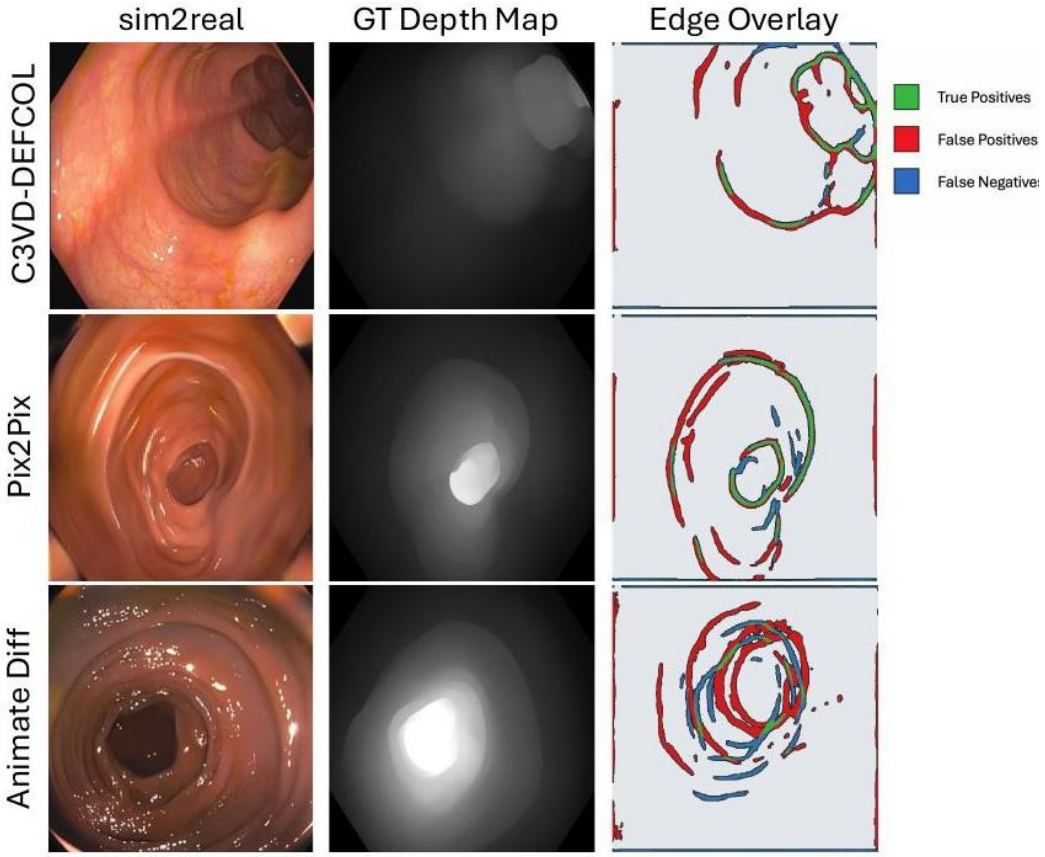


HaCohen, Yoav, et al. "LTX-2: Efficient joint audio-visual foundation model." arXiv preprint arXiv:2601.03233 (2026).

C3VD-DEFCOL Validation

Geometric Consistency

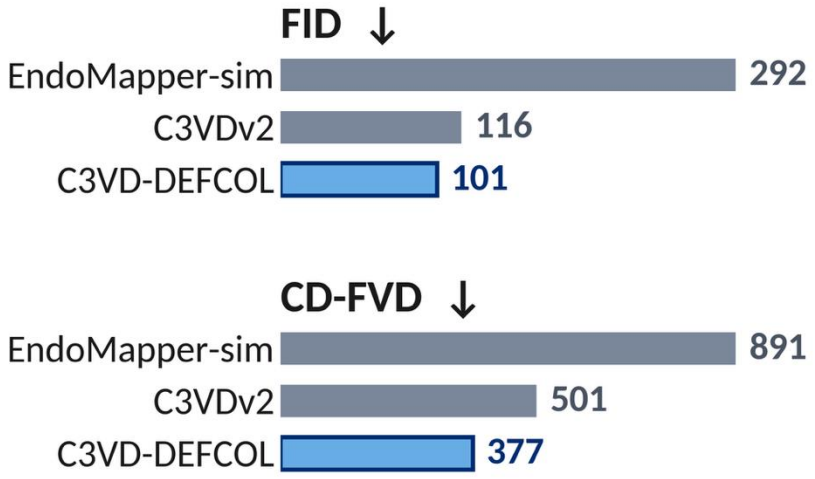
Dice = 0.69



Temporal Consistency

Method	CD-FVD ↓	SG tracks			SIFT tracks		
		# feat. ↑	≥ 5 ↑	≥ 10 ↑	# feat. ↑	≥ 5 ↑	≥ 10 ↑
Pix2Pix	1033.82	72.8	0.220	0.060	17.1	0.171	0.061
AnimateDiff	1004.24	**152.9**	0.079	0.007	0.5	0.007	0.000
C3VD-DefCol	**373.17**	92.0	**0.366**	**0.151**	**20.9**	**0.259**	**0.092**

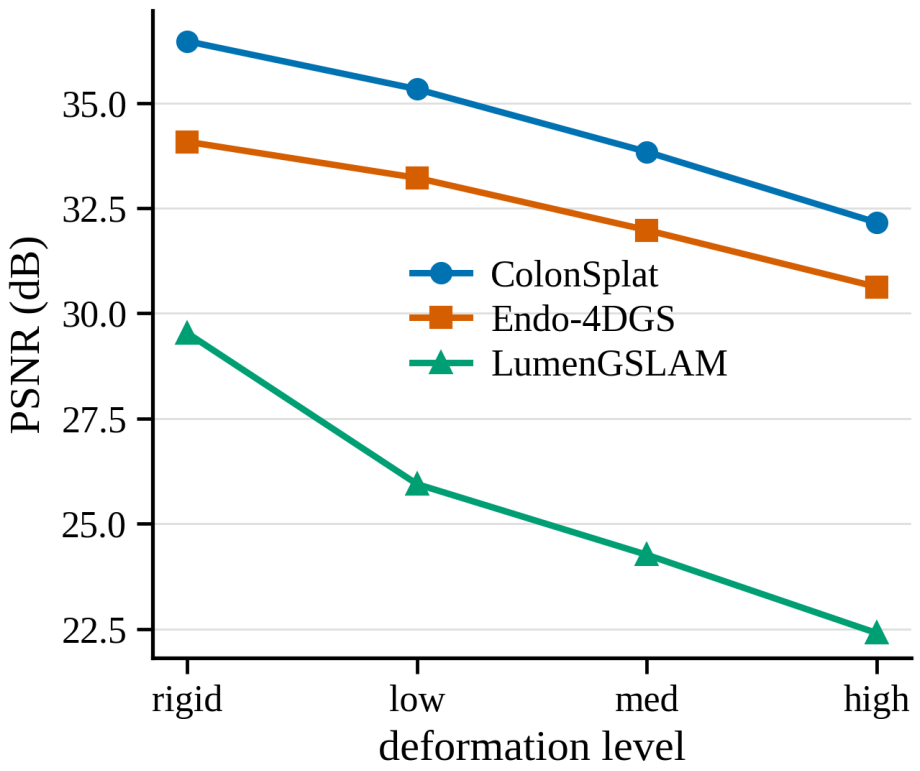
Appearance Realism

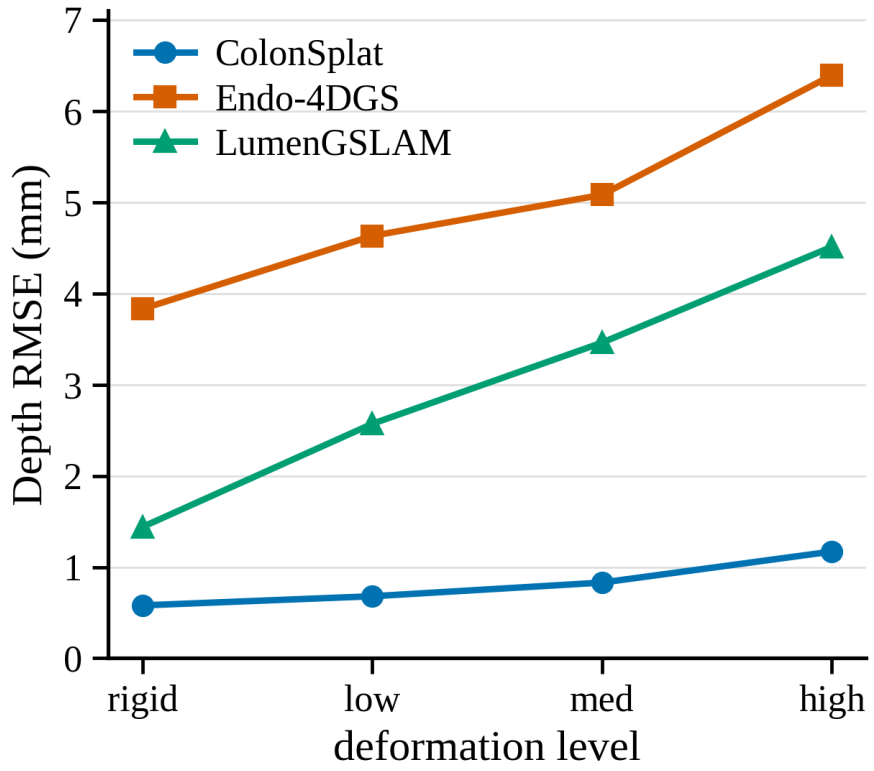


Deformable 3D Reconstruction

Depth error ↑ as deformation severity ↑

LumenGSLAM, which assumes a rigid scene, shows the largest rigid-to-high deterioration.





Six matched sets with ground-truth depth and camera poses. Depth RMSE is scale aligned.

Smolak-Dyzewska, Weronika, et al. "ColonSplat: Reconstruction of peristaltic motion in colonoscopy with dynamic gaussian splatting." *arXiv preprint arXiv:2603.06860* (2026).
Huang, Yiming, et al. "Endo-4dgs: Endoscopic monocular scene reconstruction with 4d gaussian splatting." *International Conference on Medical Image Computing and Computer-Assisted Intervention*. Cham: Springer Nature Switzerland, 2024.
Leni, Francesco, et al. "LumenGSLAM: online physically based rendering with Gaussian Splatting for robust endoscopic reconstruction and tracking." *International Journal of Computer Assisted Radiology and Surgery* (2026): 1-10.

Thanks!

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C3VD-DEFCOL

Deformation

https://durrlab.github.io/C3VDv3/

