Robotic- and Vision-Based Assistance for Next Generation Head and Neck Surgery

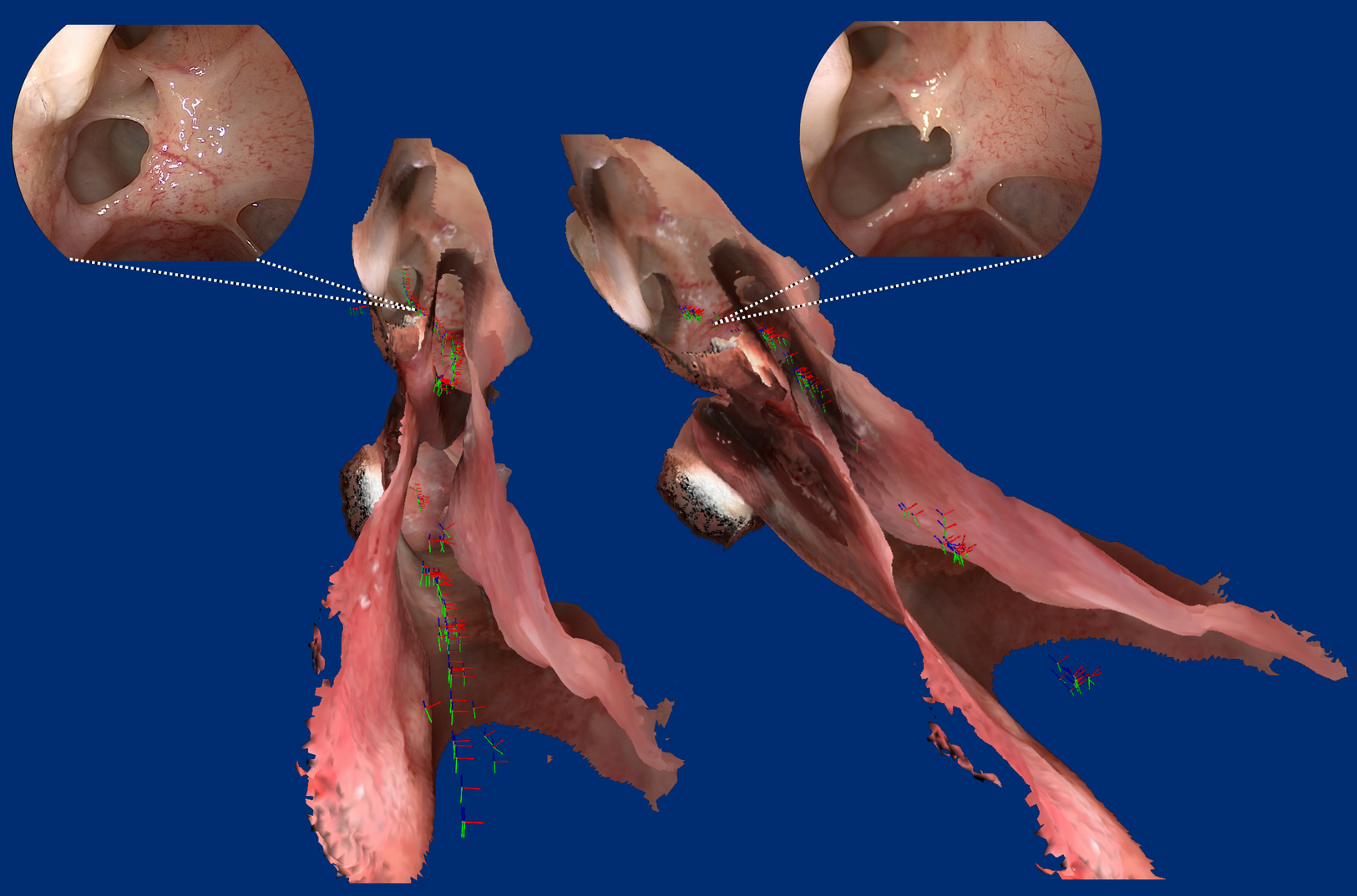
Jan Mangulabnan, Roger Soberanis, Isabela Hernández, Manish Sahu, Jonas Winter, Swaroop Vedula, Masaru Ishii, Gregory Hager, Russell H. Taylor, and Mathias Unberath

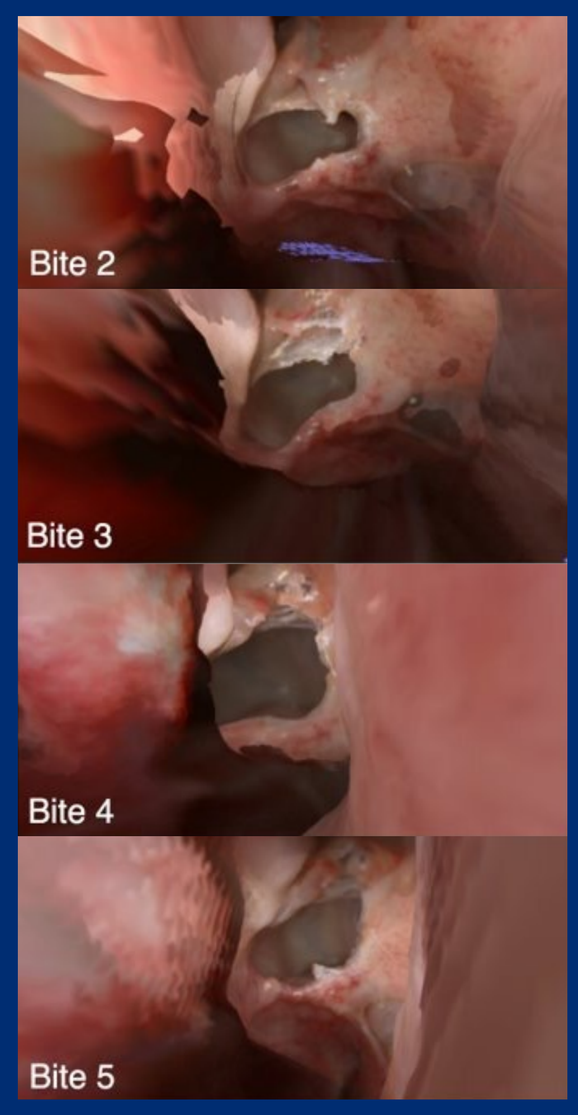
Endoscopic navigation guides surgeons through intricate anatomies to improve patient outcomes during surgical intervention.

Standard approaches like optical and electromagnetic tracking require additional resources that may **negatively impact clinical workflow**.

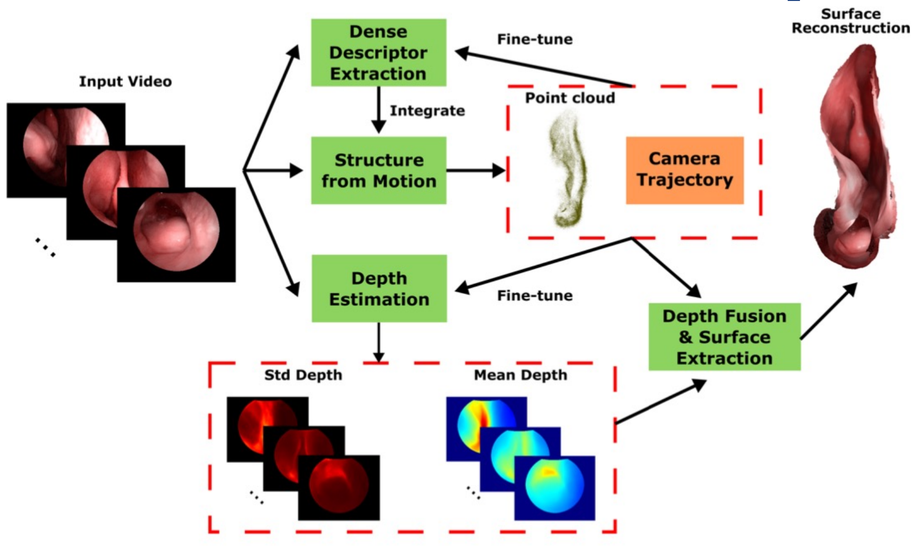
Vision-based solutions provide **advanced visualization** and **improved spatial understanding** at **no additional hardware cost**.

Monitoring anatomical change during sinus surgery in 3D reconstruction from endoscopic videos



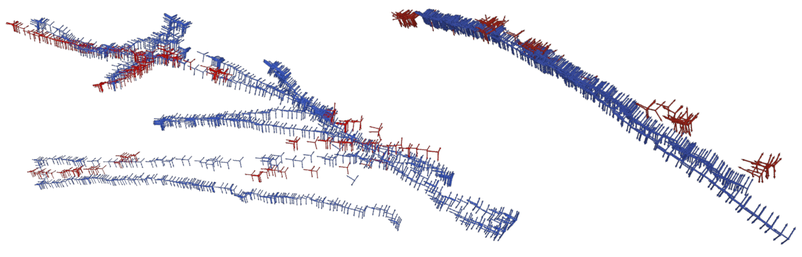


Dense Reconstruction Pipeline



During surgical intervention, the endoscope is frequently inserted and removed losing spatial calibration to the 3D structure.

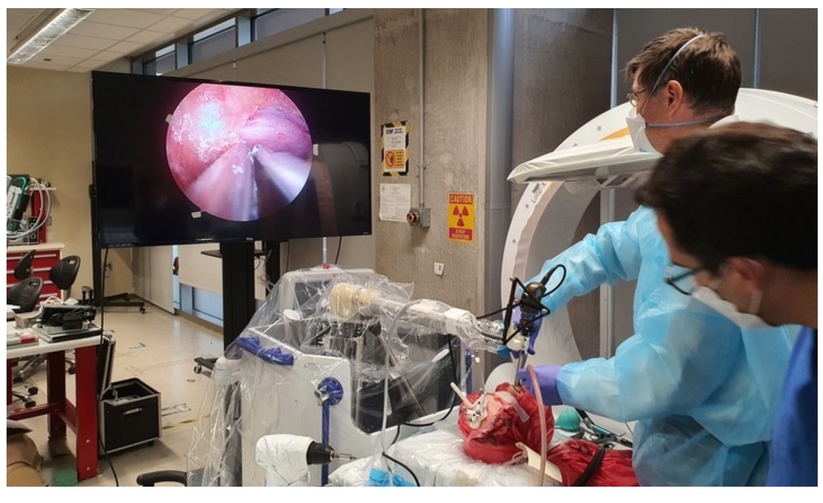
Blue: Ground Truth
Red: Estimated



Investigating **camera relocalization** using **Perspective n-Point**

Robot-Assisted Endoscopy

Endoscopes enable **minimally invasive** skull-base surgery through the nasal cavity.



Galen Robot for **hand-over-hand** control using virtual fixtures for **improved precision and accuracy**

References

[1] Liu, X., Zheng, Y., Killeen, B., Ishii, M., Hager, G.D., Taylor, R.H., Unberath, M.: Extremely Dense Point Correspondences using a Learned Feature Descriptor. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 4847–4856 (2020)

[2] Liu, X., Stiber, M., Huang, J., Ishii, M., Hager, G.D., Taylor, R.H., Unberath, M.: Reconstructing sinus anatomy from endoscopic video – towards a radiation-free approach for quantitative longitudinal assessment. In: Martel, A.L., Abolmaesumi, P., Stoyanov, D., Mateus, D., Zuluaga, M.A., Zhou, S.K., Racoceanu, D., Joskowicz, L. (eds.) Medical Image Computing and Computer Assisted Intervention