

# 3-D Operation Situs Reconstruction With Time-of-Flight Satellite Cameras Using Photogeometric Data Fusion

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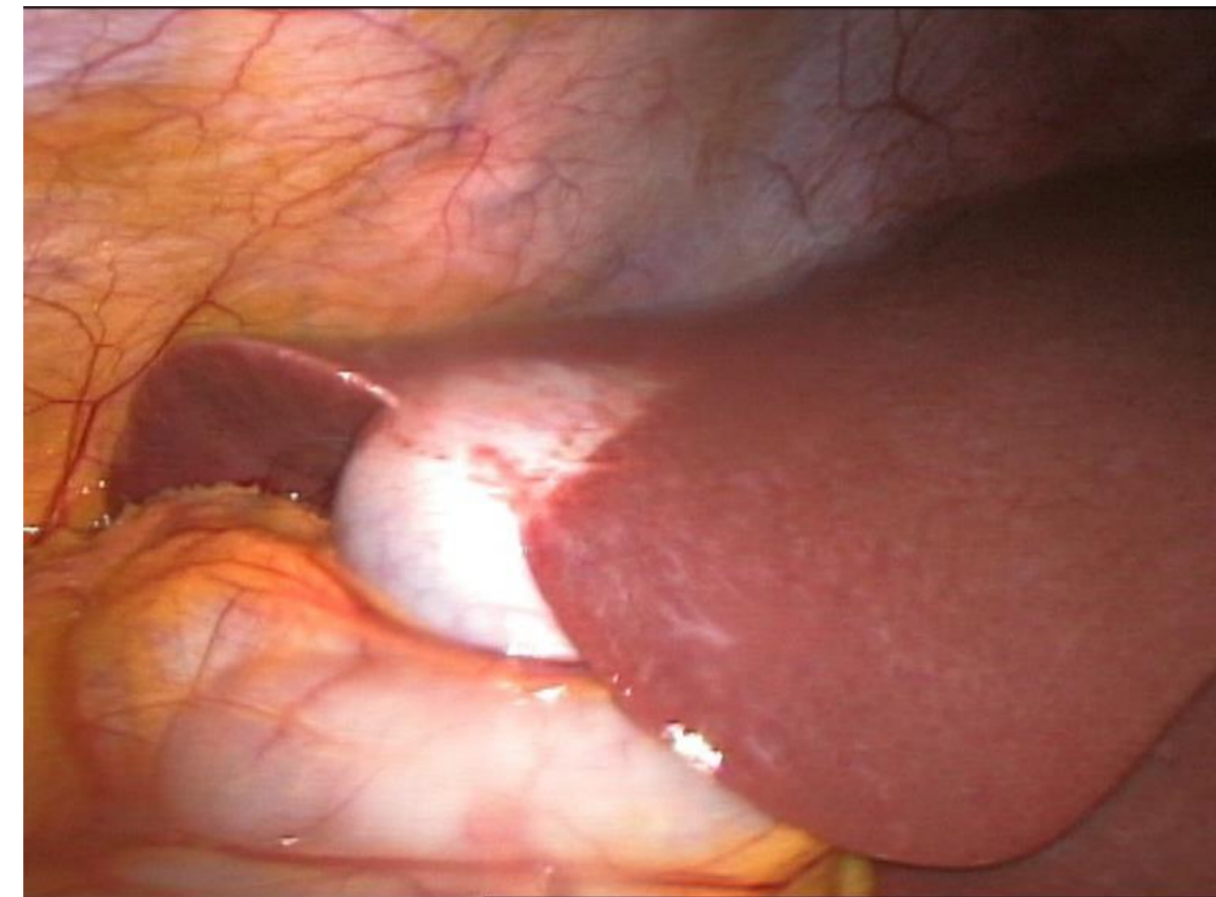
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## Minimally Invasive Procedures

- + Reduced pain
- + Less scars
- + Short recovery time
- Difficult orientation
- Narrow field of view

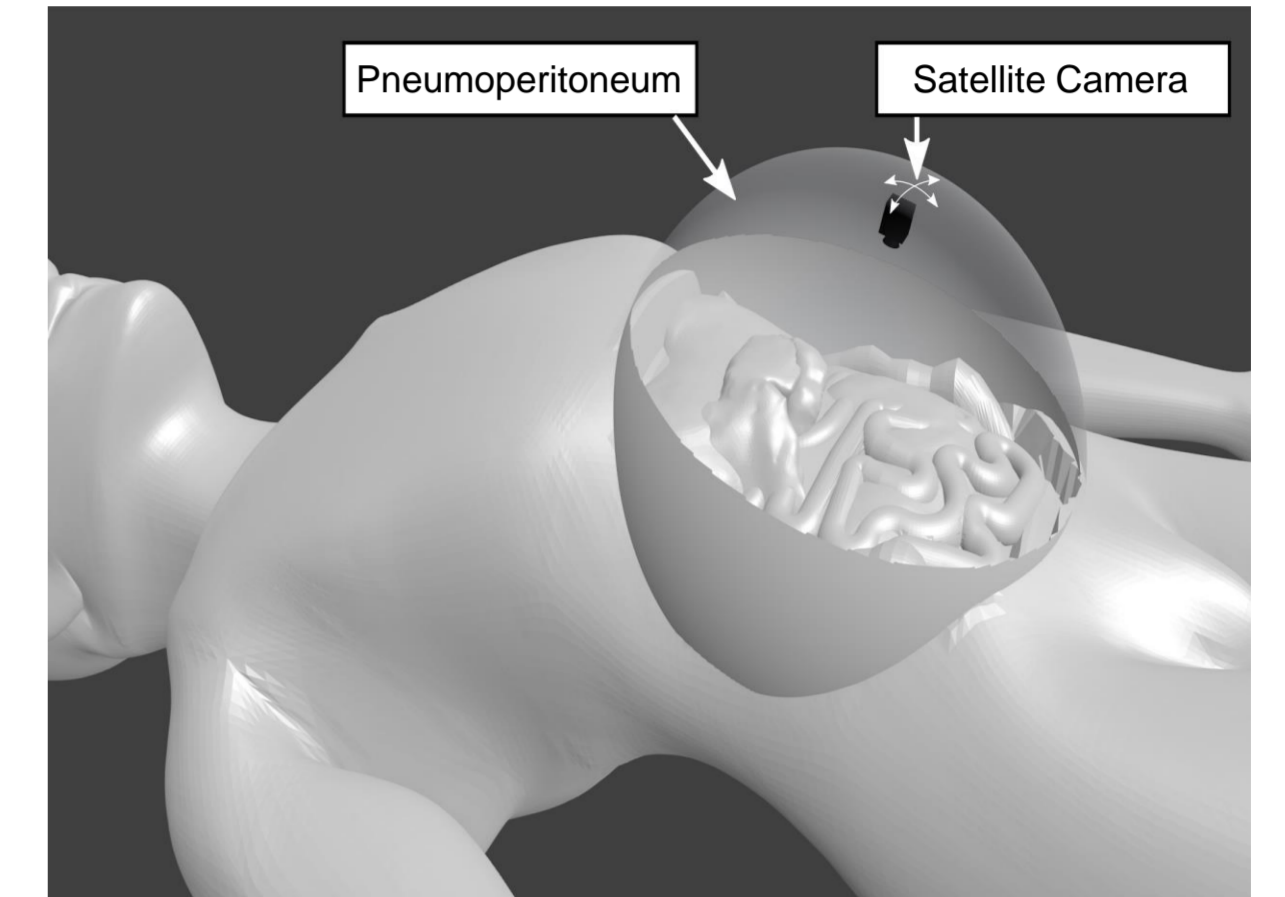
Hardware Goals



## 3-D Satellite Cameras

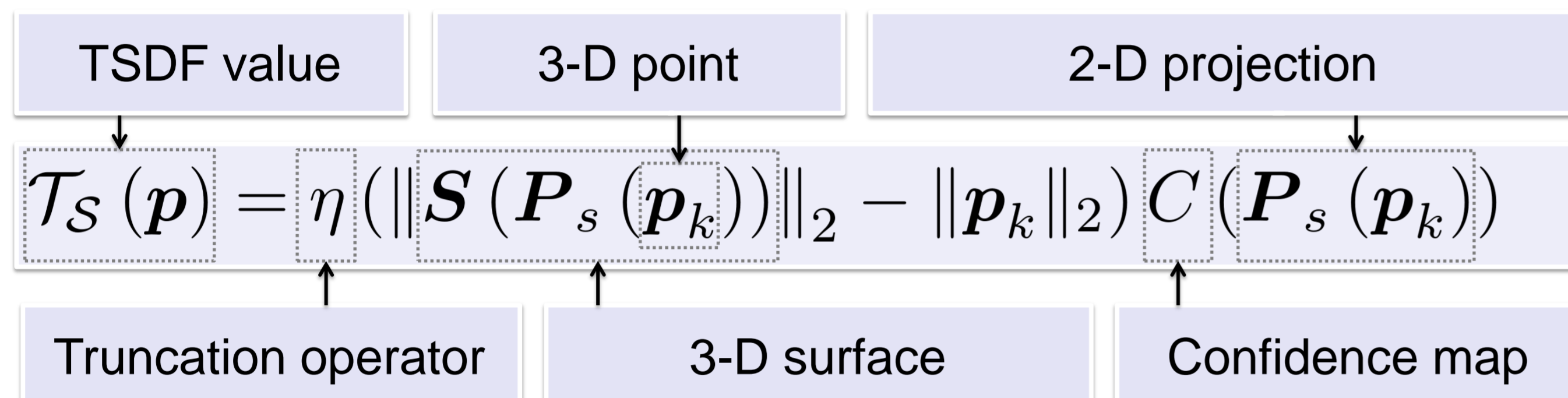
- + Overview of the situs
- + No trocar is blocked
- + Topographic data
- Prototype status
- Narrow field of view

Software Goals



## 3-D Operation Situs Reconstruction

- Multi-view photogeometric data fusion (4-D ICP) [1]
- Truncated signed distance function (TSDF) [2]
- Rigid model assumption (high frame rate)



- Data fusion for normalized amplitude data

$$\mathcal{T}_A(\mathbf{p}) = \tilde{a}(\mathbf{P}_s(\mathbf{p}_k)) C(\mathbf{P}_s(\mathbf{p}_k))$$

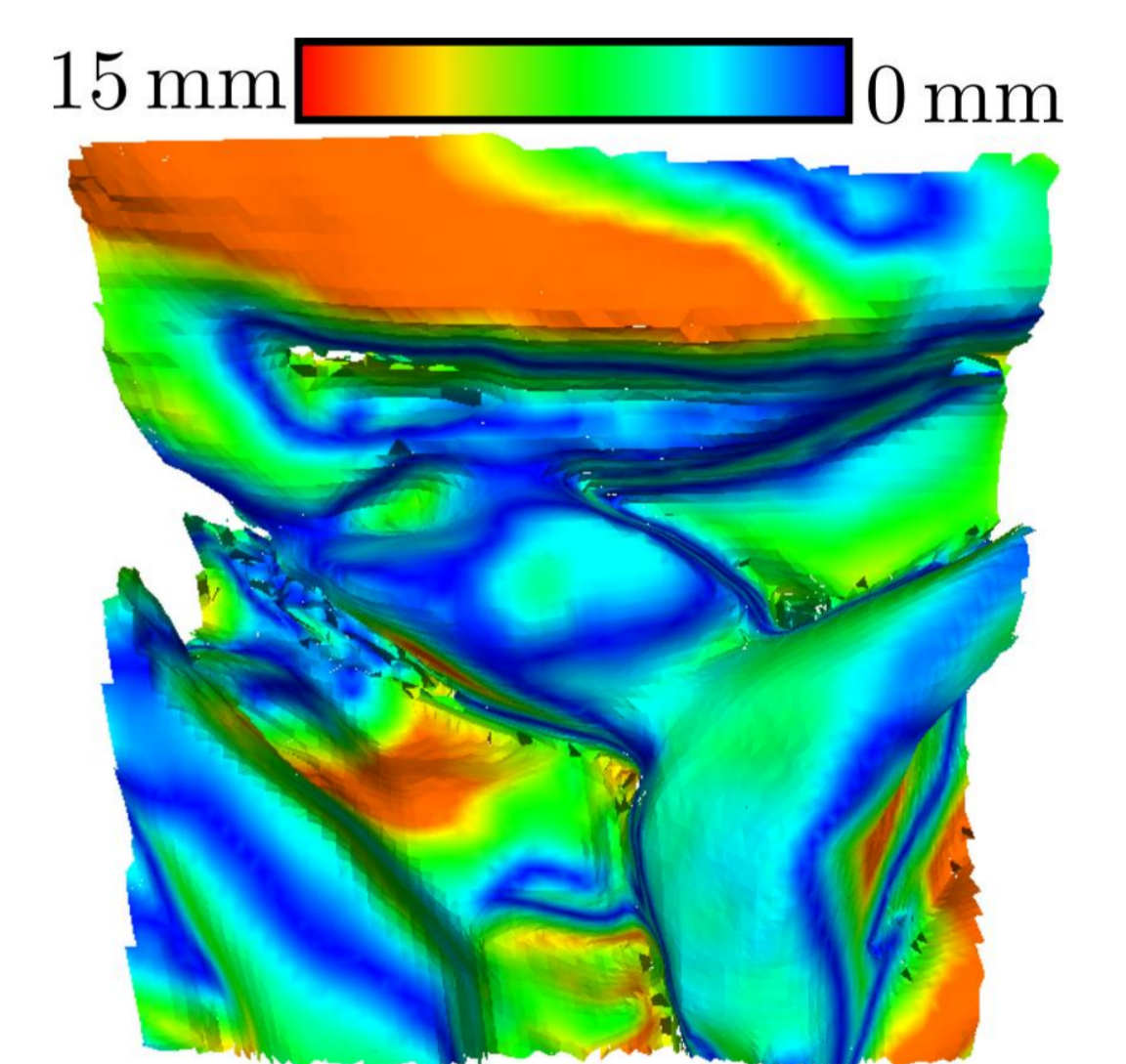
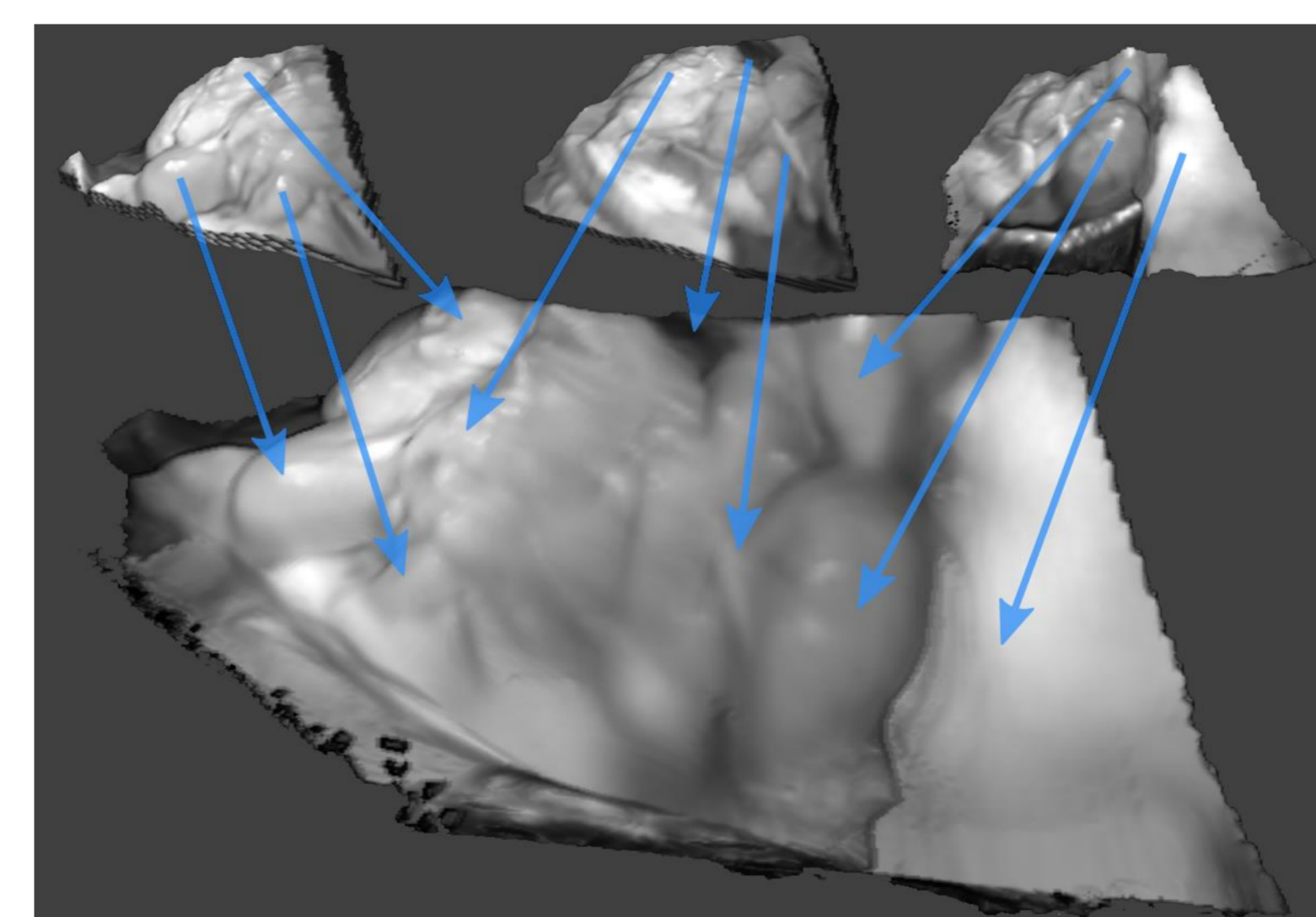
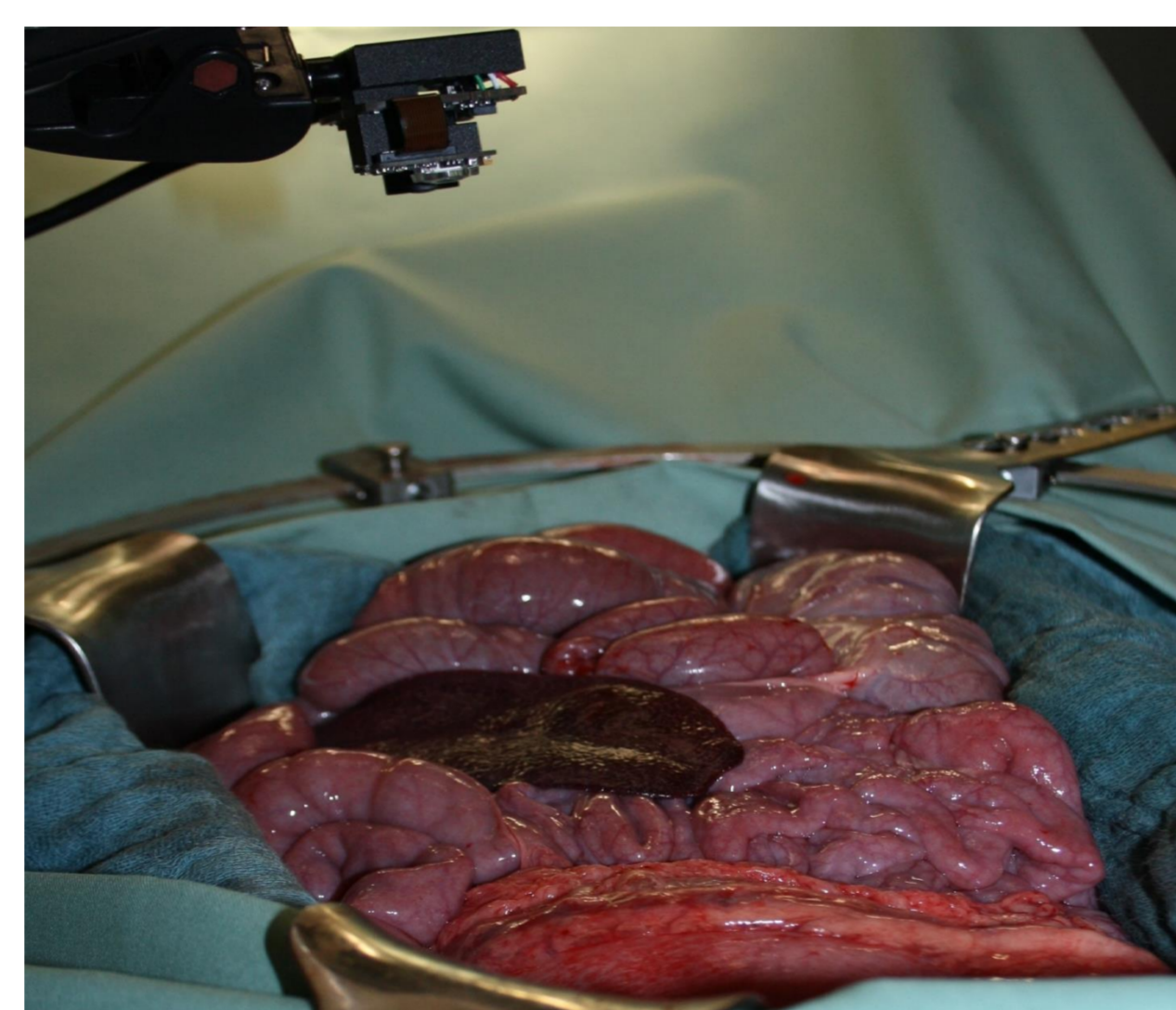
- Confidence map considering sensor characteristics [3]

- Sensor specific validity map
- Inhomogeneous illumination
- Amplitude related errors

$$C(\mathbf{x}) = e^{-\frac{\alpha}{\tilde{a}(\mathbf{x})}} e^{-\frac{\|\mathbf{x}-\mathbf{c}\|}{\beta}} v(\mathbf{x})$$

## Experiments and Results

- PMD CamBoard Nano Time-of-Flight camera (160 × 120 px; max 90Hz)
- Pig study for in-vivo data (25 frames for fusion)
- Human phantom data for quantitative evaluation (CT and ToF data)



## Summary and Outlook

- Initial 3-D surface model including photometric data
- Early prototype satellite camera (needs reduced size)
- Low signal-to-noise ratio (needs improved hardware)

## References

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- [2] Newcombe, R.A. et al.: *KinectFusion: Real-time dense surface mapping and tracking*. In: *10th IEEE International Symposium on Mixed and Augmented Reality*. (October 2011) 127-136
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