Combining Depth Fusion and Photometric Stereo for Fine-Detailed 3D Models

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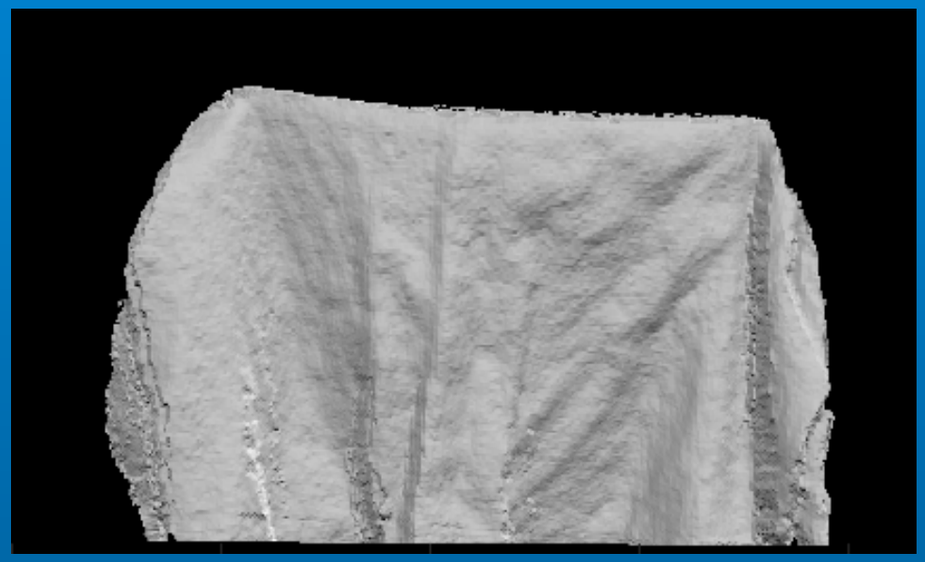
Outline

- **Motivation / Goal**
- **Method**
- **Results**
- **Conclusion**

Motivation / Goal



3D Model standard approach

Fusion of depth images:

- **Noisy and low resolution depth images**
- **Smooth surfaces from weighted average**
- **Lack of details!**

Motivation / Goal

How can we achieve this?

Grayscale Image

3D Model (Spoiler)

Grayscale Image

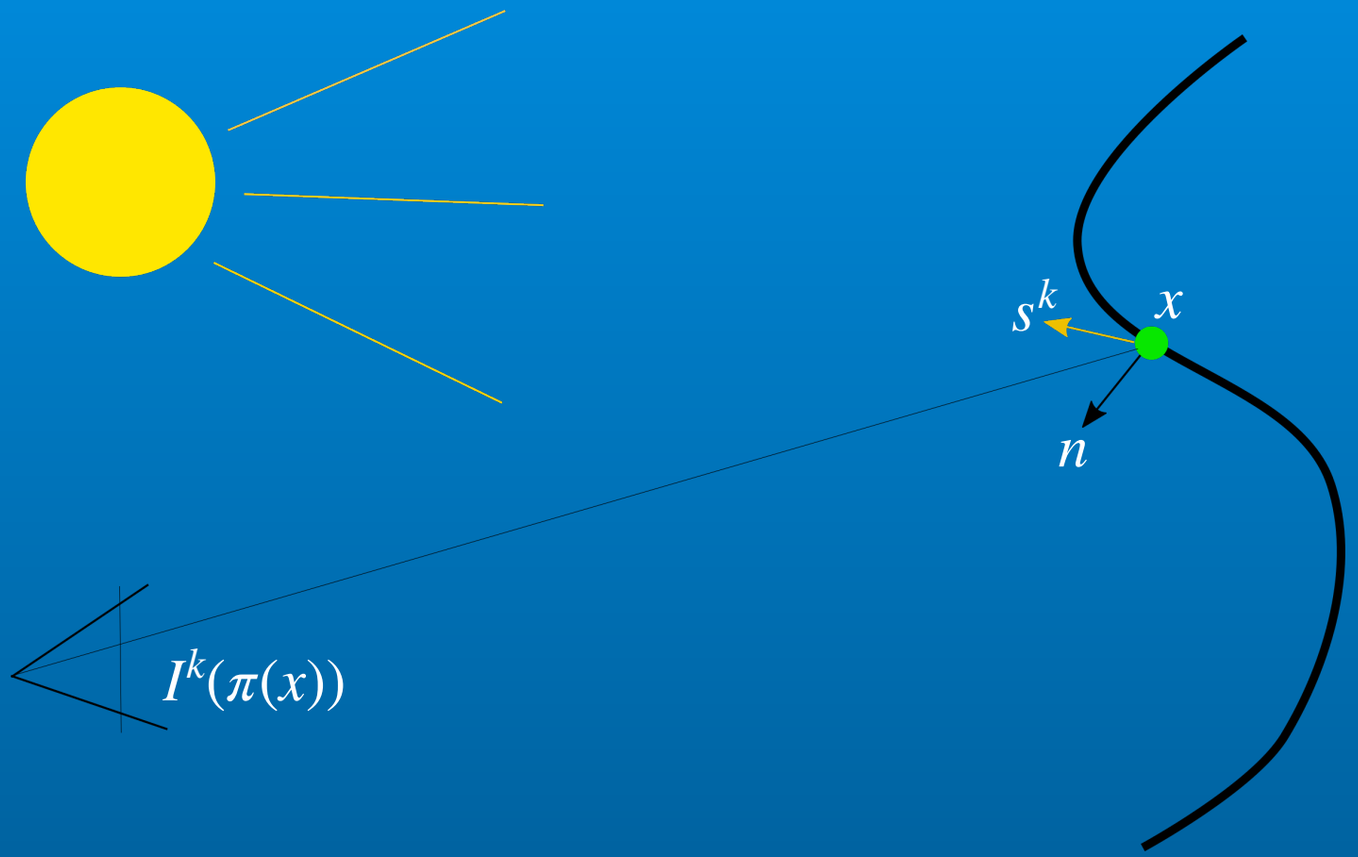
Method

Photometric stereo - Capture Details

Same object, looks different - Look at the illumination

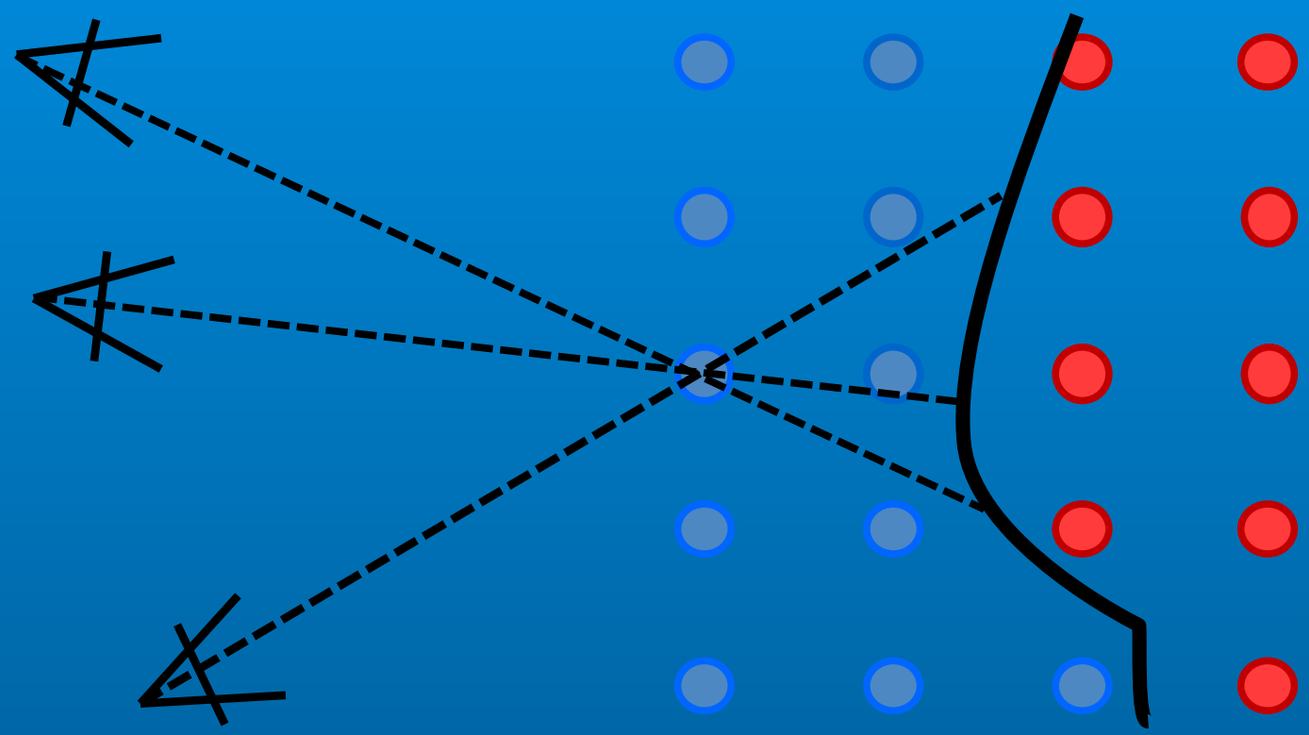
Method

Lambertian Model



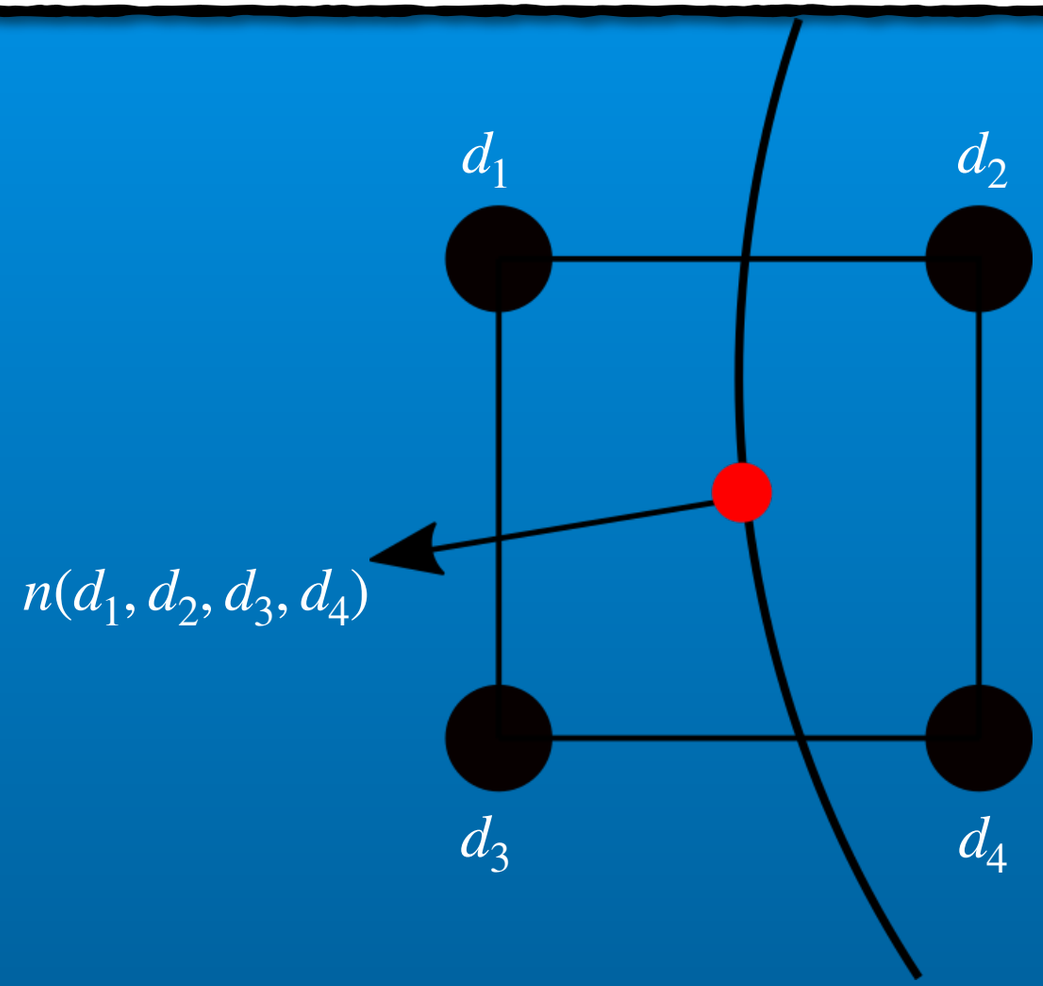
$$I^k(\pi(x)) = \rho(x)n(x)^T s^k$$

Depth Fusion



$$D = \frac{\sum_{k=1}^{K} w^k d^k}{\sum_{k=1}^{K} w^k}$$

TSDF:s



Error Functions

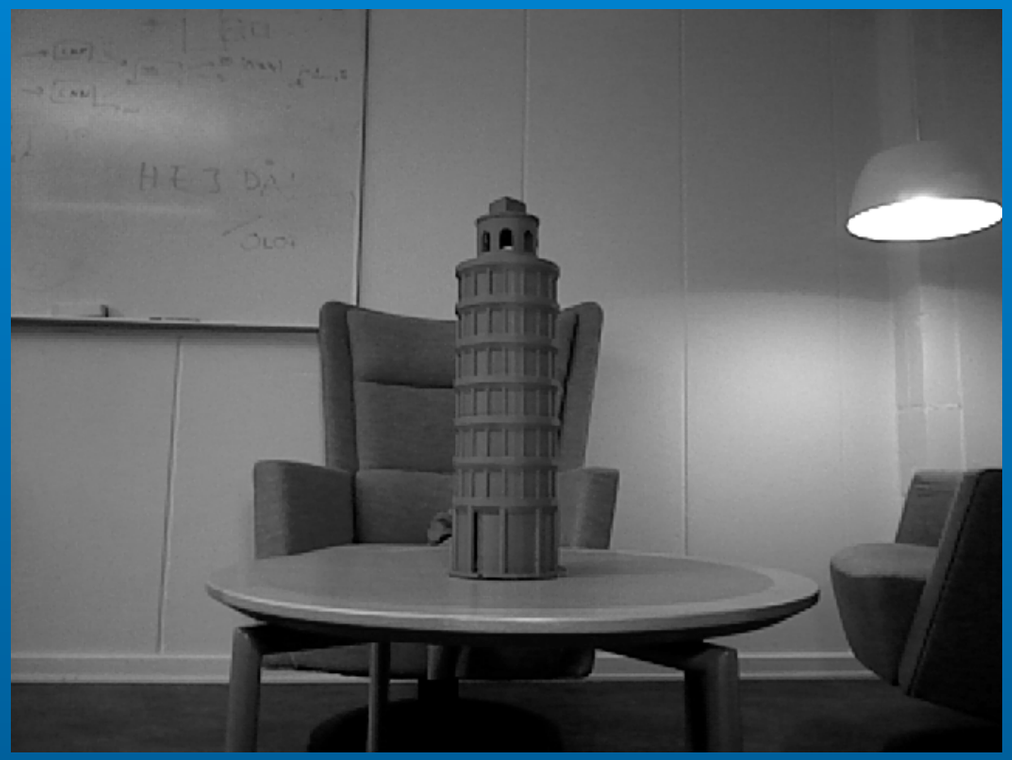
$$E_{Lamb}(\mathbf{d}, \rho, s^1, \ldots, s^K) = \sum_{k=1}^{K} \sum_{V \in \mathscr{V}^k} \sum_{x \in V \cap \mathcal{S}} (I^k(\pi(x)) - \rho(x, \rho_V)\tilde{n}^T(x, d_V)\tilde{s}^k)^2$$

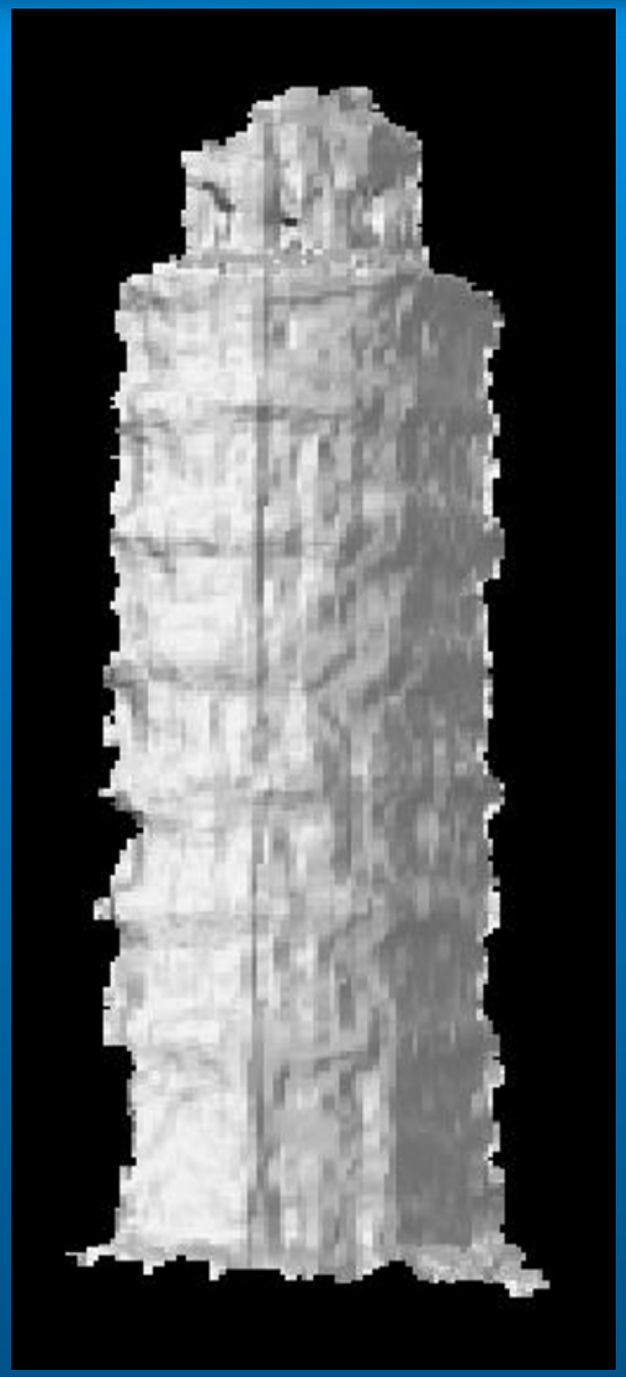
$$E_{depth} = \sum_{k=1}^{K} \sum_{v \in \mathscr{V}^k} (D^k(x_v) - d_v)^2$$

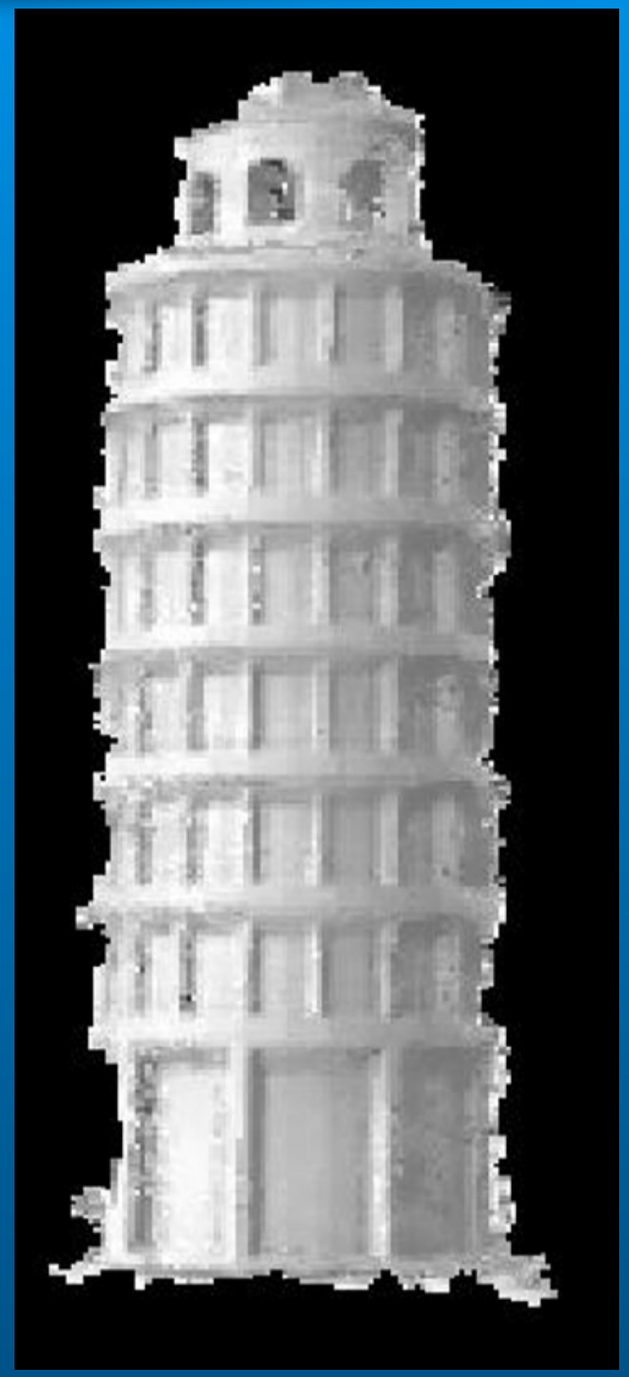
$$E_{albedo} = \sum_{V \in \mathscr{V}} \sum_{v_i \neq v_j \in V} (\rho_{v_i} - \rho_{v_j})^2$$

$\tilde{n}, \tilde{s} \in \mathbb{R}^9$ – **Spherical Harmonics**

Results







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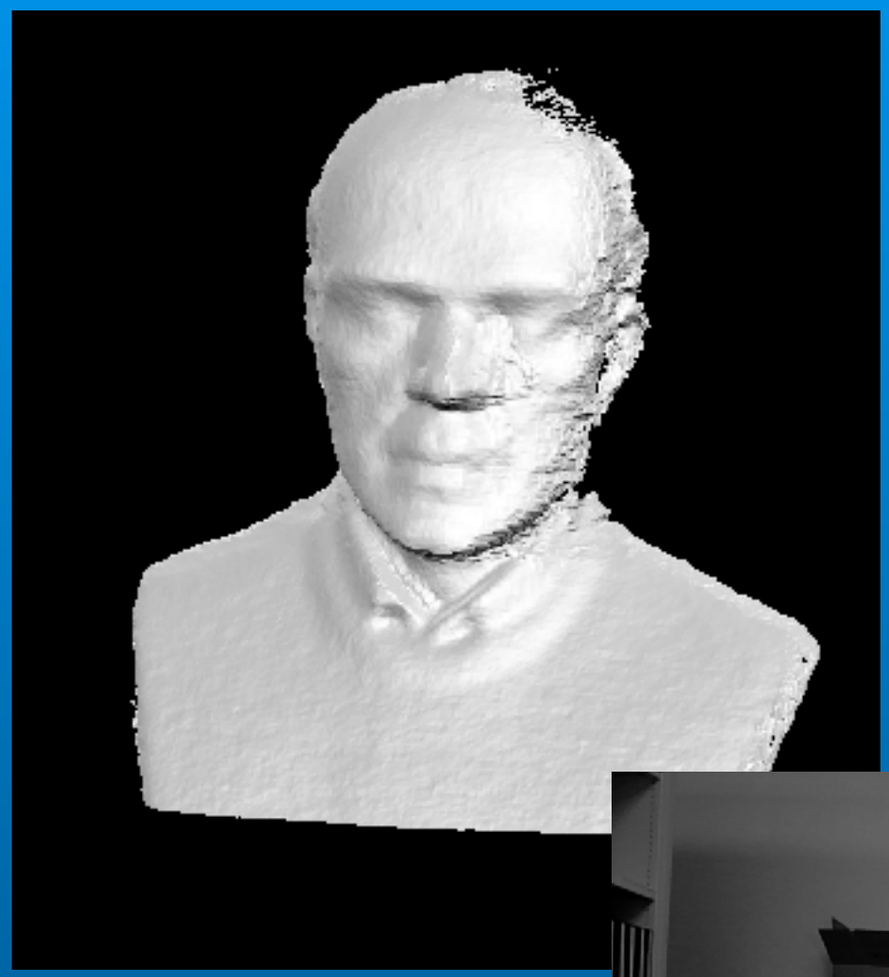
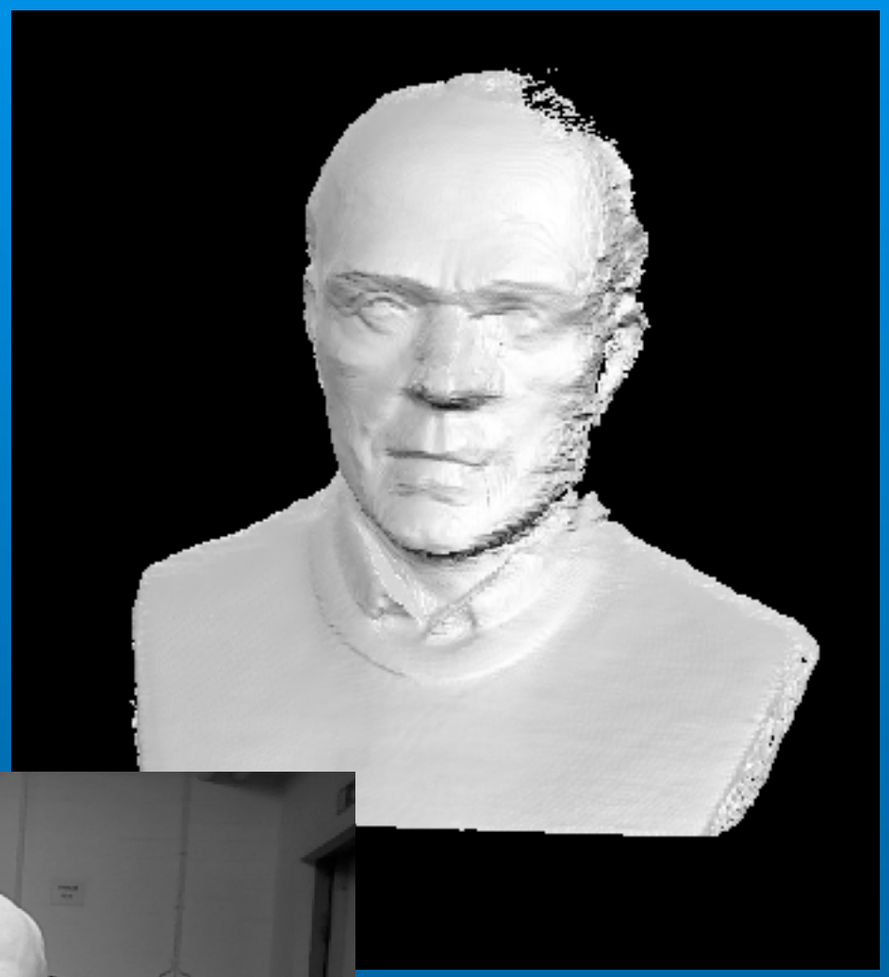
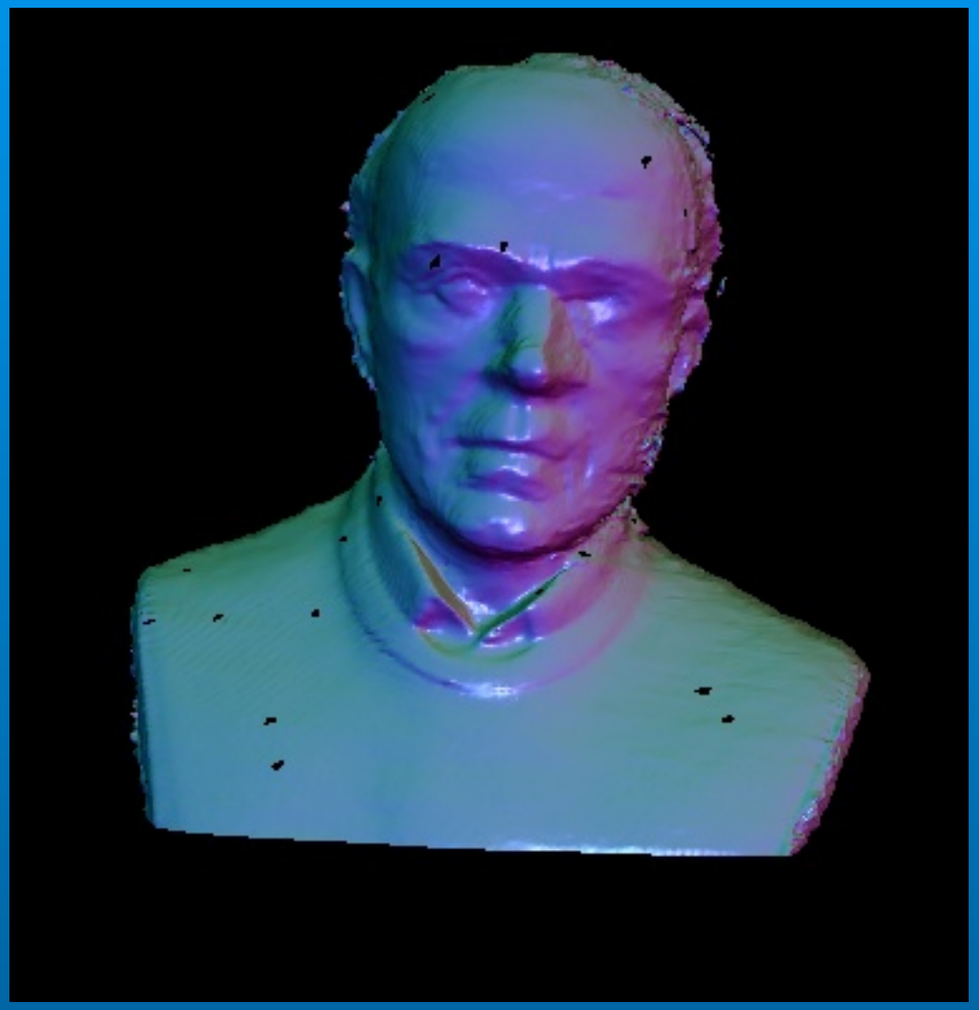
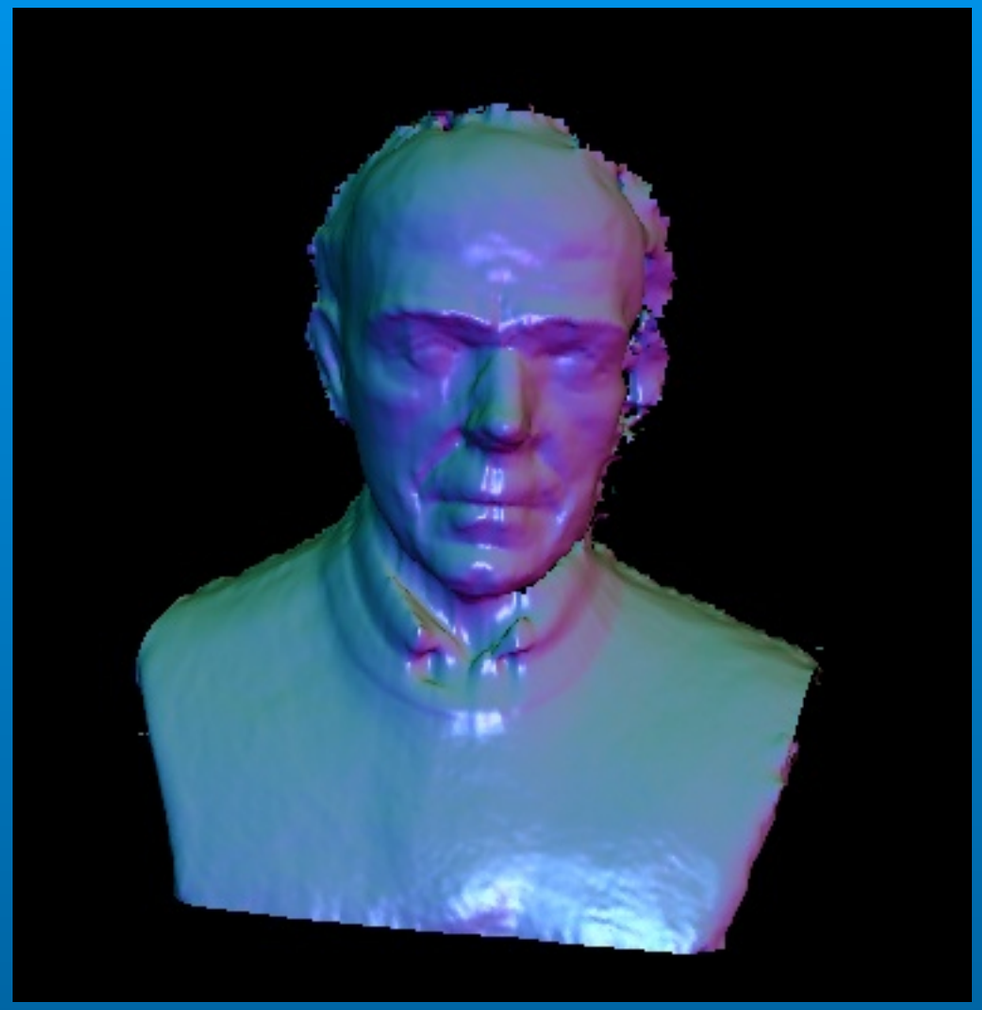


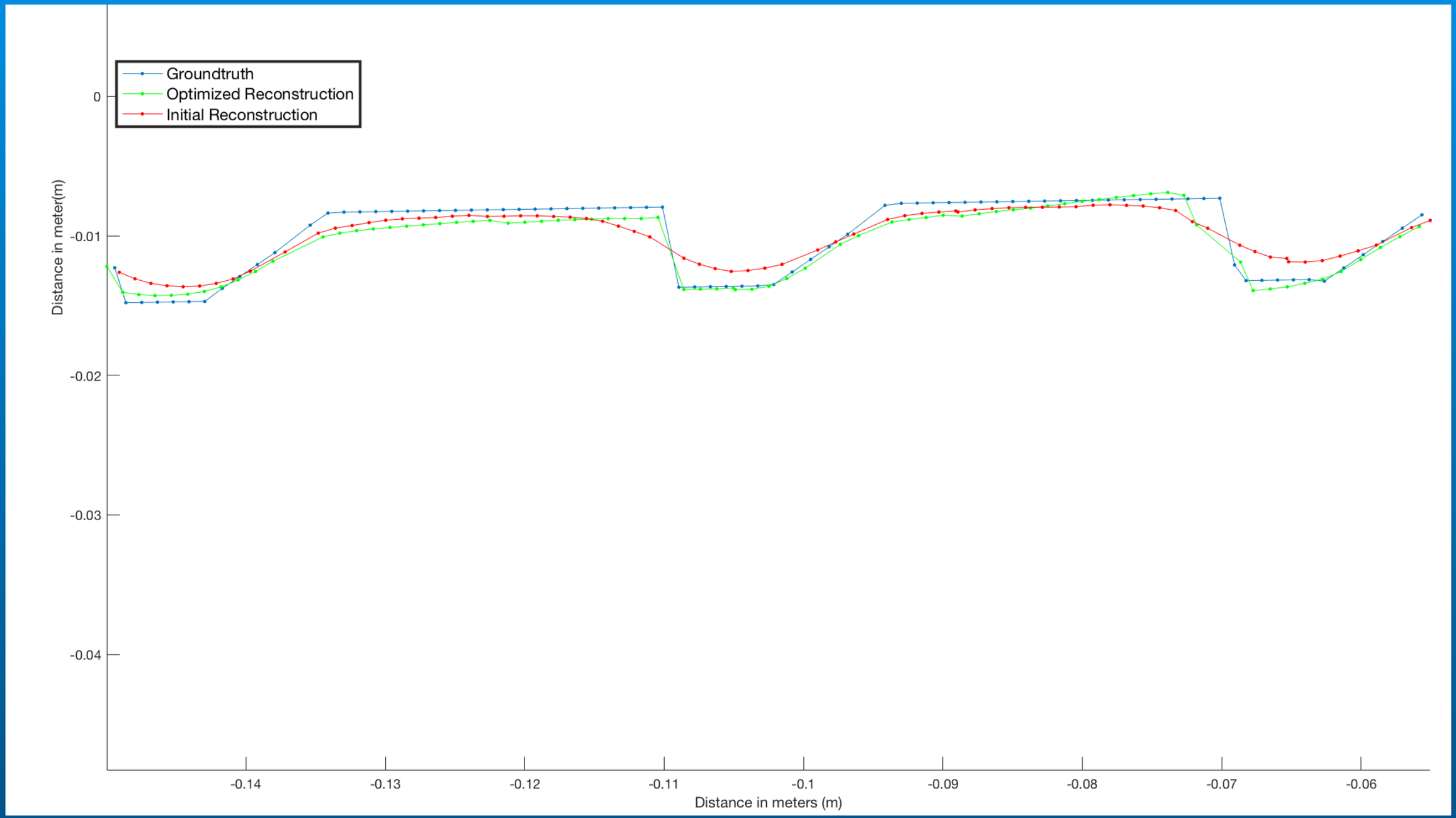


Results





Quantitative Results



Conclusion

- **Promising result**
- **Hard to separate albedo and shading**
- **Non-uniform albedo is a challenge**