Homework Assignment 5
15-463 Computational Photography F22
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Monday, November 21th, 2022

1. Photometric stereo

Uncalibrated photometric stereo

A_e

N_e

A_Q

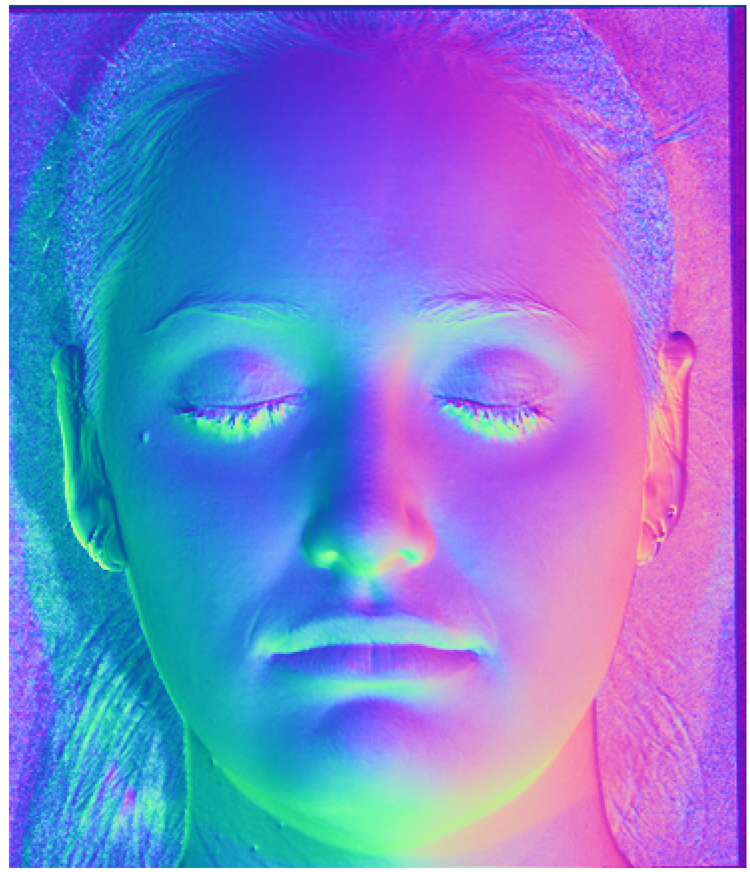
N_Q

$$\text{with } Q = \begin{bmatrix} 1 & 0.1 & 0.3 \\ 0 & 1 & 0.5 \\ 0 & 0 & 1 \end{bmatrix}$$

Enforcing integrability

$$\Delta = \begin{bmatrix} 0.04973182, & -0.21561331, & 1 \\ -0.48112999, & 0.34238336, & 0 \\ -0.19683446, & -0.75072059, & 0 \end{bmatrix}$$

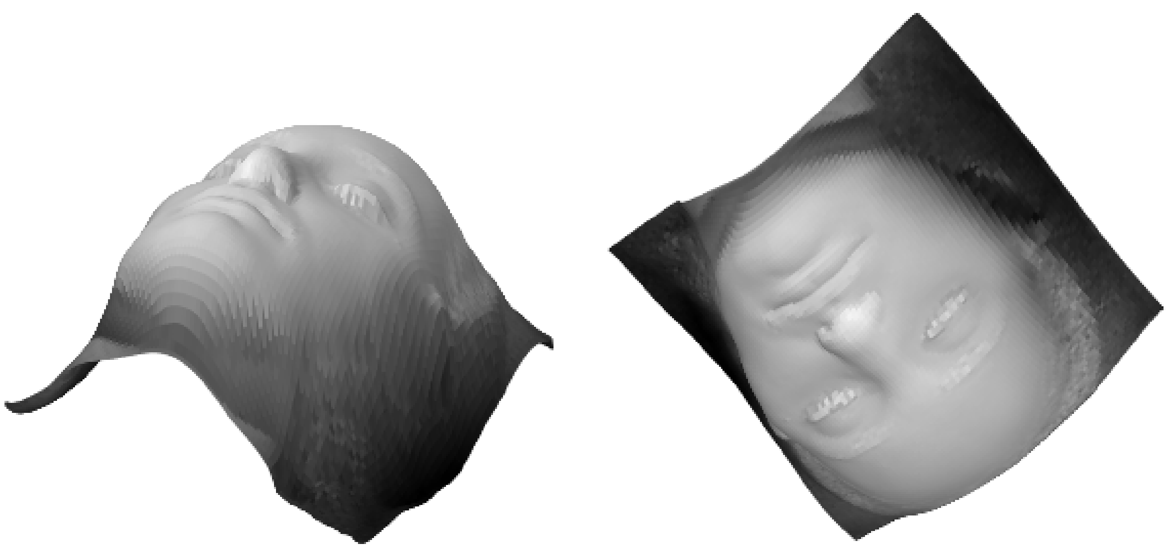
albedos



normals

Normal integration

depth image



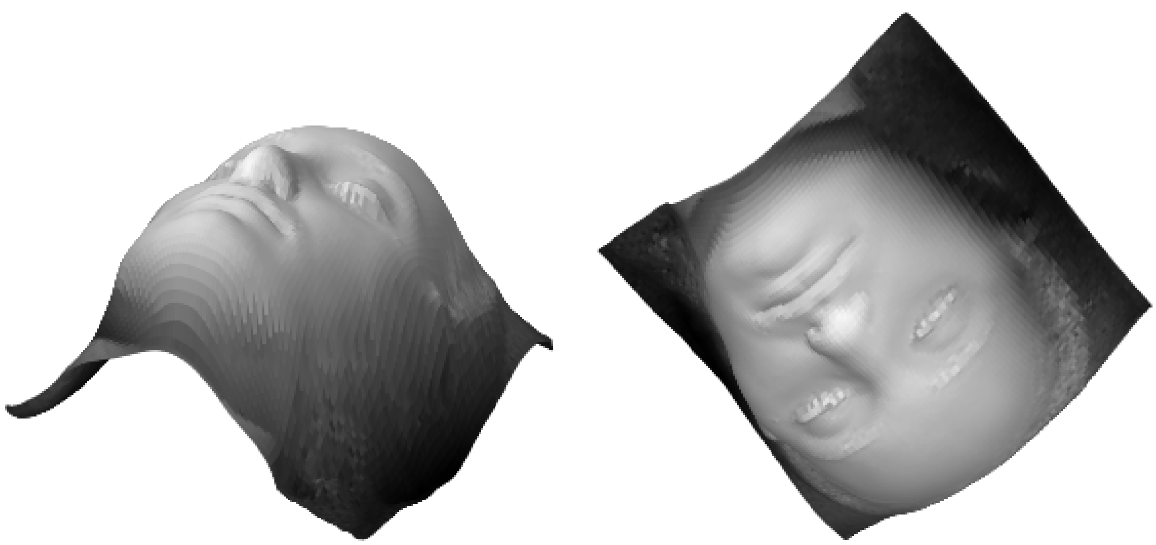
3D surface

GBR with $\mu = -0.1$, $\nu = 0.1$, $\lambda = 1.5$:

albedos

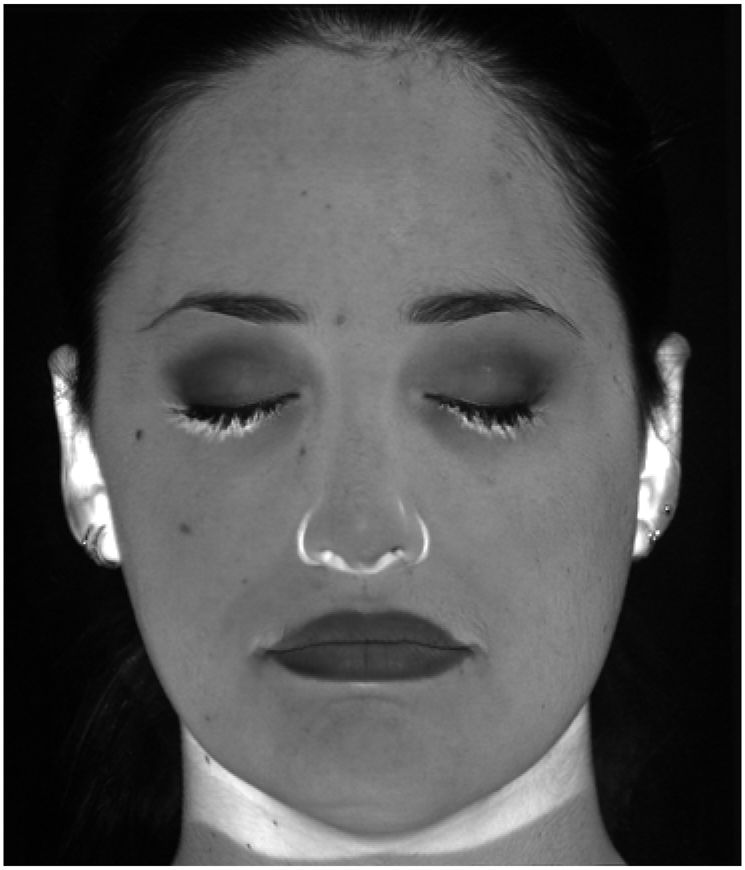
normals

depth image

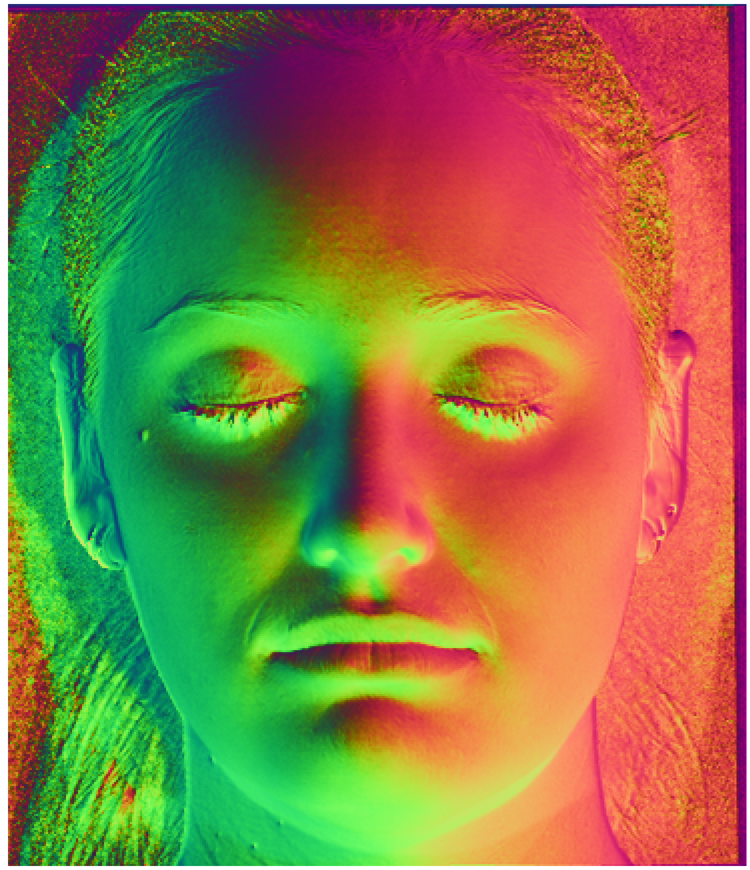


3D surface

Calibrated photometric stereo

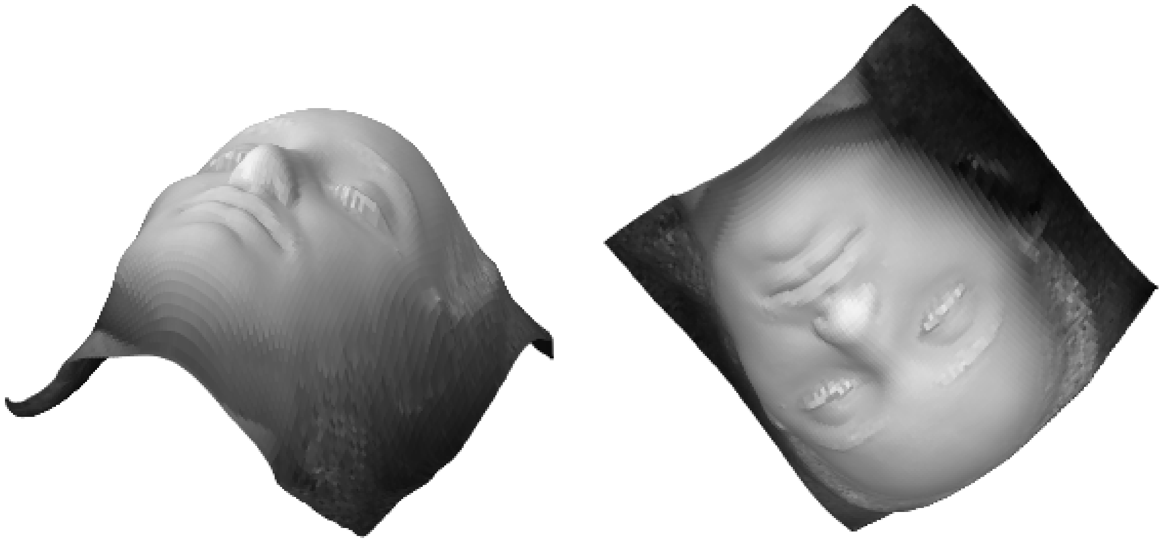


albedos



normals

depth image



3D surface

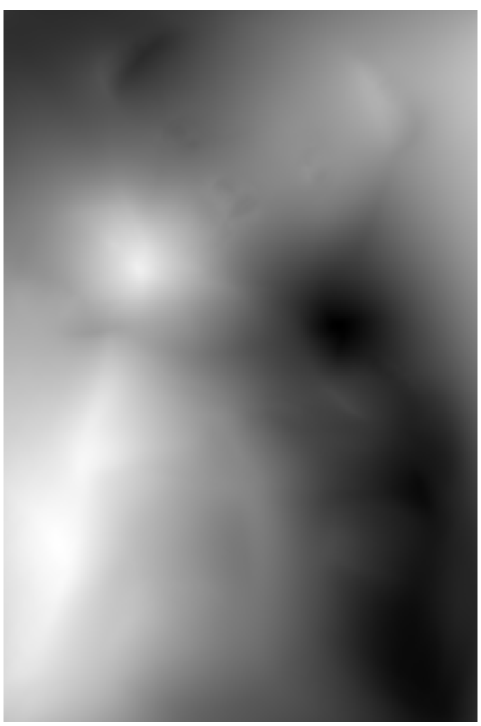
How these results compare to the uncalibrated case is that the albedos highlight specific areas due to the light sources being given versus the uncalibrated that had more ambient lighting around the entire image for the albedos. For the normals, we see a difference in coloring with a blue to pink tone for the uncalibrated versus the green to red tone for the calibrated case. Both the depth images and 3D surfaces looked similar between the two cases.

2. Capture and reconstruct your own shapes

image

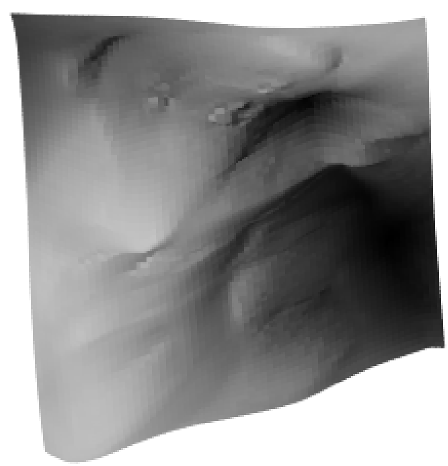
albedos

normals



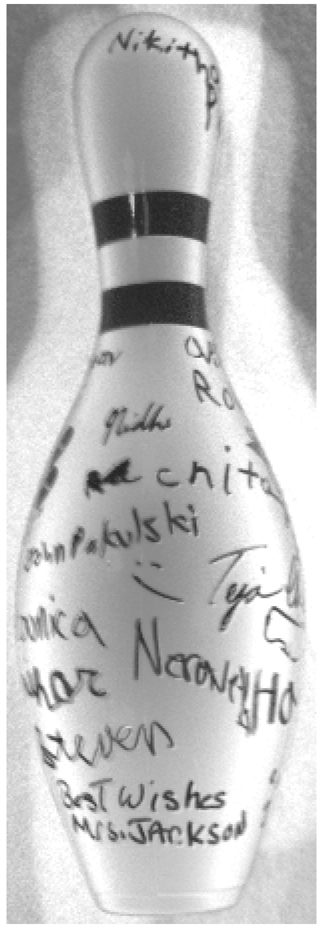
depth image

3D surface



The depth map showed signs of the algorithm working correctly, but due to the many uneven variations in depths between the arms and legs of the teddy bear, the depth map provided a slightly inaccurate representation of the real depth as shown by the distorted reintegrated surface.

image



albedos

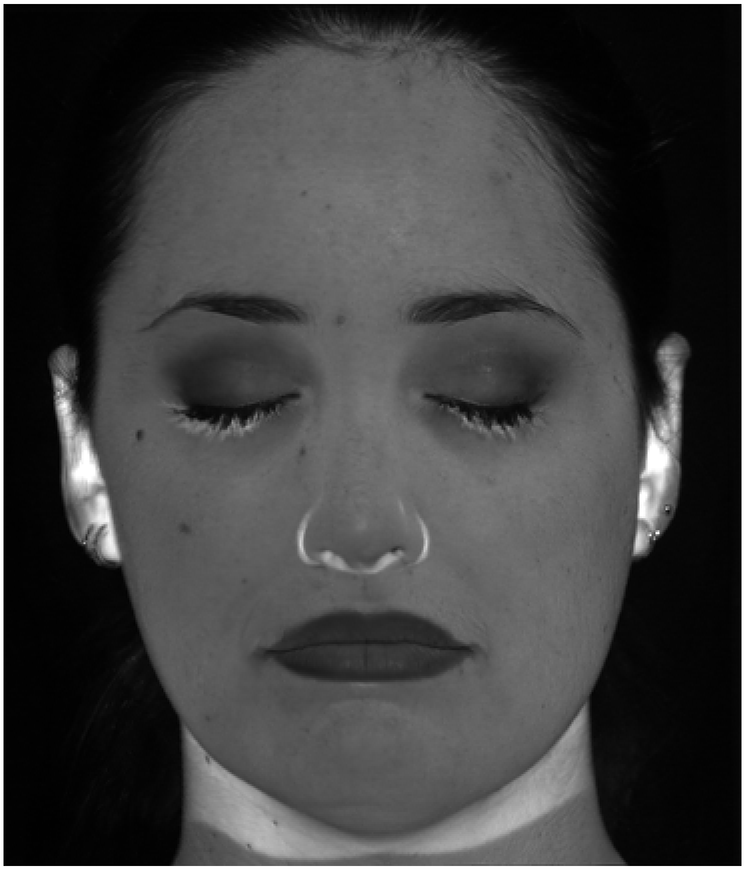
normals

depth image

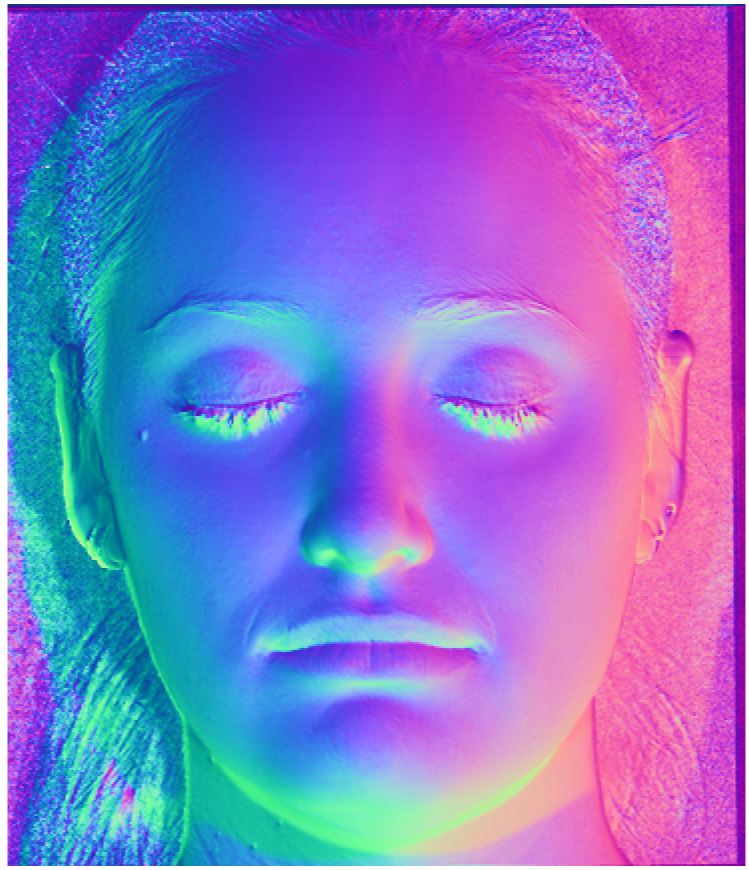
3D surface

3. Bonus: Resolving the GBR ambiguity

Using perspective cameras

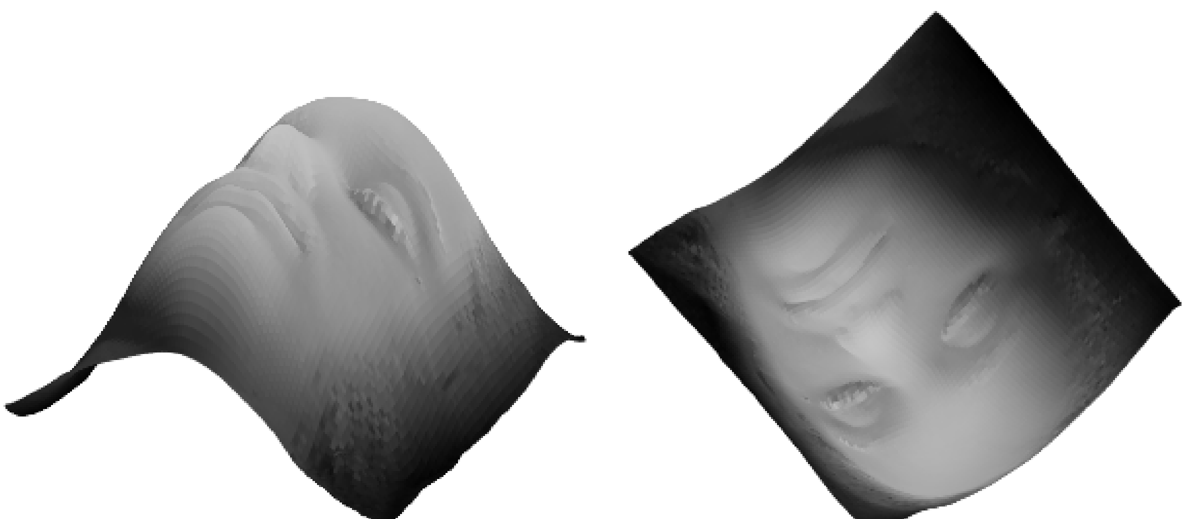


albedos



normals

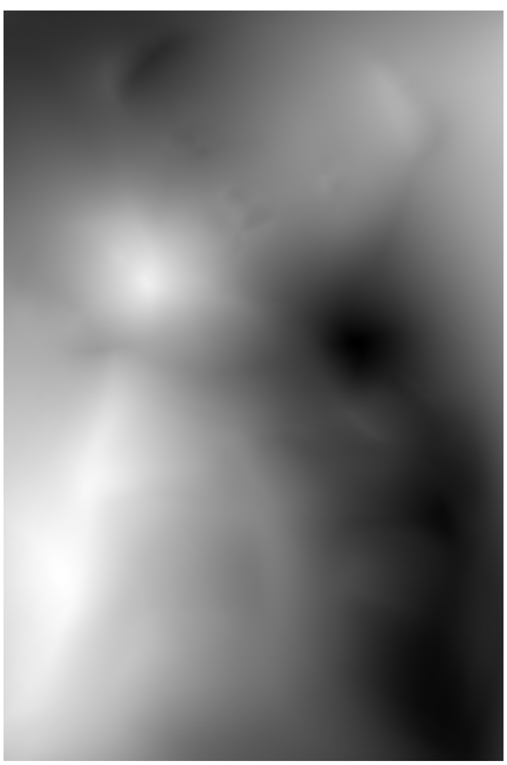
depth image



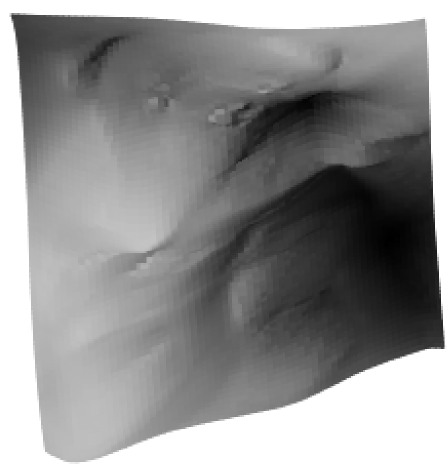
3D surface

albedos

normals



depth image

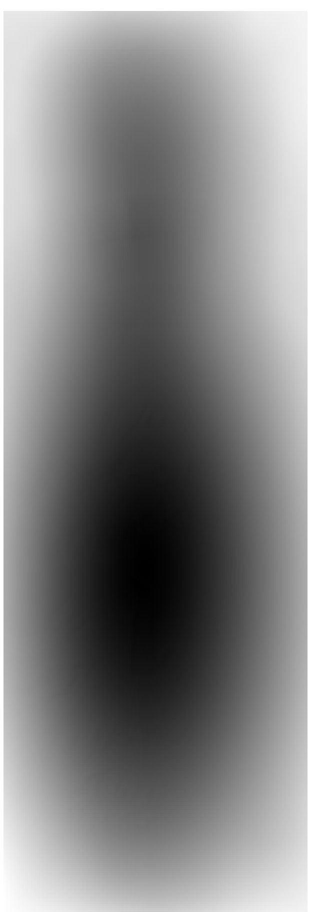


3D surface

image

albedos

normals



depth image

3D surface