Assignment 6

15663 Computational Photograpy Fall 2023
DUE: December 08, 2023

1 Implementing structured-light triangulation (100 points)

1.1 Video processing (25 points)

Per-frame shadow edge estimation For each frame t, you need to estimate the lines $\lambda_h(t)$ and $\lambda_v(t)$, running along the right shadow edges on the unobstructed horizontal and vertical planar regions, respectively.

For the vertical planar region, we chose $(250, 0)$ as the upper-left corner and $(800, 300)$ as the bottom-right corner. For the horizontal planar region, we chose $(200, 660)$ as the upper-left corner and $(830, 768)$ as the bottom-right corner. The regions are shown below:

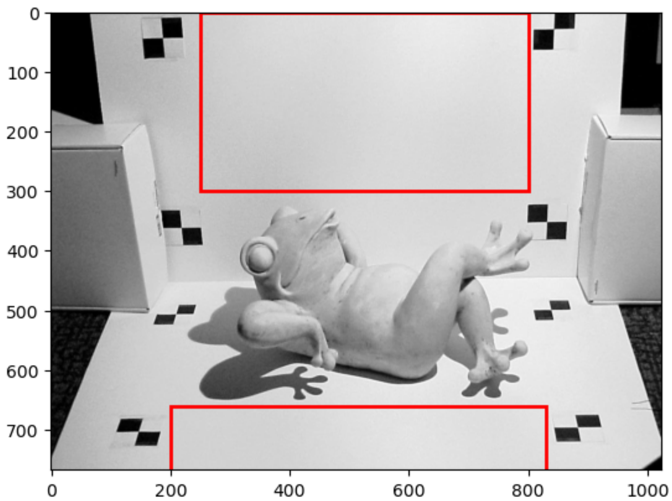

Figure 1: Caption

Visualization of the shadow edge estimates:

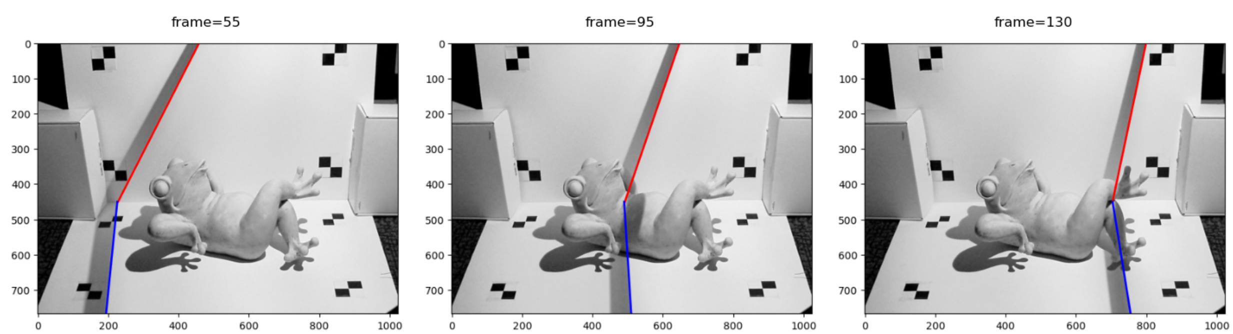

Figure 2: Caption

Per-pixel shadow time estimation To perform 3D reconstruction, you need to also estimate the per-pixel shadow times. For each pixel (x, y), you can estimate its shadow time $t_{shadow}(x, y)$ by finding the zero-crossing of the difference image $\Delta I(x, y, t)$ as a function of time t.

Visualization of the per-pixel shadow time estimates:

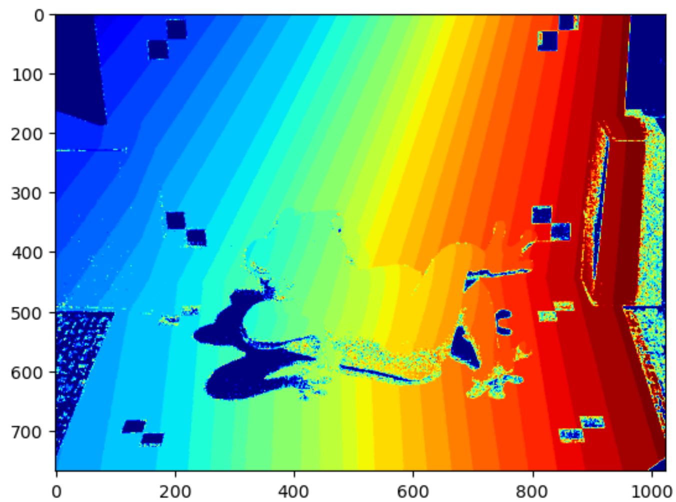

Figure 3: Caption

2 Intrinsic and extrinsic calibration (50 points)

Intrinsic calibration The resulting camera intrinsic parameters are saved in `./result/camera/intrinsic_calib.npz`.

Calibration of ground planes The resulting camera extrinsic parameters are save in `./result/camera/extrinsic_calib.npz`.

Calibration of shadow lines The 3D points $P1$, $P2$, $P3$ and $P4$ are saved in `./result/camera/reconstructed_points.npz`.

Calibration of shadow planes The estimated shadow plane parameters ($P1$ and $\hat{n}$ are saved in `./result/camera/shadow_planes.npz`

2.1 Reconstruction (25 points)

First, crop the part of the image you want to reconstruct. Then, for each pixel $p = (x, y)$ in this rectangle, fetch its shadow time $t_{shadow}(x, y)$. Next, fetch the shadow plane $S(t_{shadow}(x, y))$ for that frame. Back-project the pixel p into a 3D ray r. Finally, intersect this ray with the shadow plane $S(t_{shadow}(x, y))$. The resulting intersection point P is the reconstructed 3D point corresponding to pixel p.

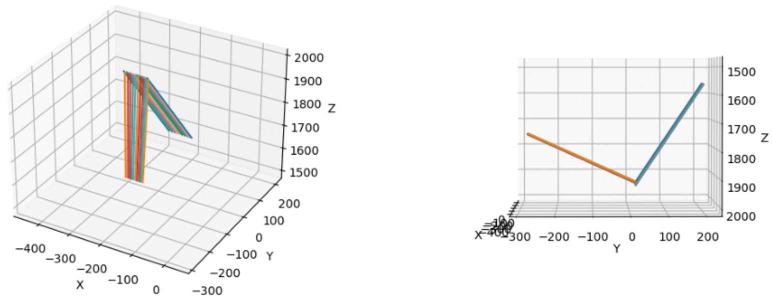

Figure 4: Caption

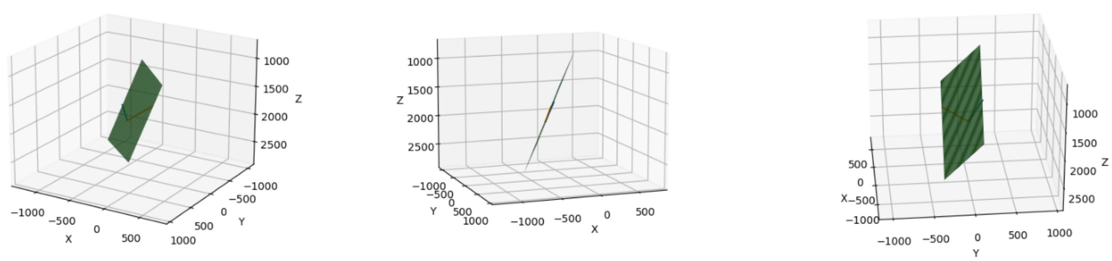

Figure 5: Caption

Repeat this process for all pixels in your cropped image, to recover a 3D point cloud.

The reconstruction results for the frog sequence:

Figure 6: Caption

3 Build your own 3D scanner (100 points)

Object 1

Object 2