

Computer Vision - Exercise 7

Shape from Silhouettes

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1 Silhouette extraction

In my implementation, I chose the silhouette threshold to be 100. Based on my experiments, when the threshold is from 80 to 90, some extra parts below the bottom of the statue is included and when the threshold is bigger than 110, some parts near the elbow is missing and the arm is much thinner than in the original one. When the threshold is 100, the extracted silhouette gives a good offset between noise level and clear extraction.



Figure 1: Extracted silhouette

2 Volume of interest

Initially I set the bounding box to be $[-3 -3 -3; 3 3 3]$ which includes the whole statue. After experimenting, I chose the bounding box to be $[0.3 -0.2 -2; 2.1 1.1 2.5]$ which is (or very close to) the smallest bounding box.

I chose the volume resolution to be $64 \times 64 \times 128$.

3 Visual hull

For each image and for each voxel (i, j, k) , I implemented the following steps:

- **Project the center of the voxel to the image**

This is done by first transforming the voxel to world coordinates using the transformation matrix then multiplying the projection matrix of the image.

- **Update score according to silhouette**

Check if the projected point in the image falls within in the silhouette, if so, add 1 to the score.

The constructed 3D model is as the following:

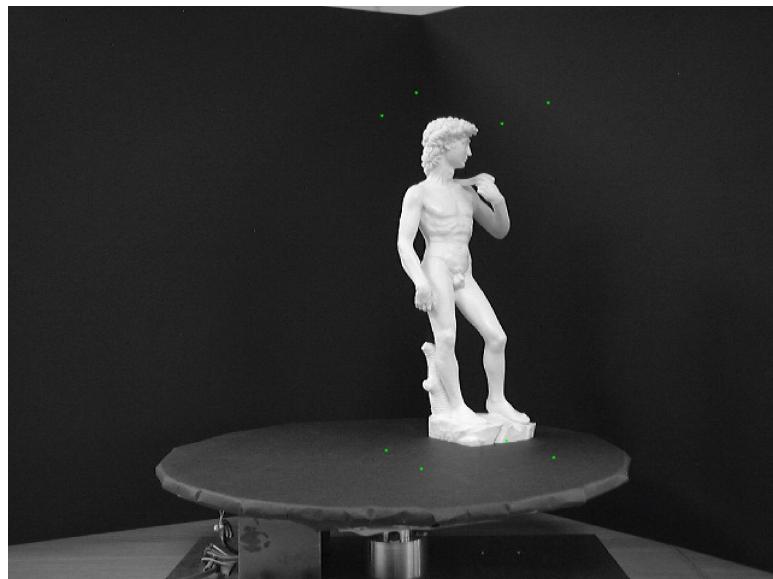


Figure 2: Volume corners (illustrated as the green points)



Figure 3: Constructed 3D models in different views

4 Improvements

4.1 The Voxel-based Method

This method first splits the object space into a 3D grid of voxels and intersects each voxel with each silhouette volume. Only voxels that lie inside all silhouette volumes remain part of the final shape and the 3D model is constructed using the `isosurface()` method from the resulting volume.

This voxel-based method has no concavities and the reconstruction is not photo-consistent. In addition, it requires the extraction of silhouettes beforehand and the quality of reconstruction is dependent on the silhouette identification.

Apart from silhouettes, the color of pixels, shading, depth and texture may also be used in 3D reconstruction.

4.2 Possible Improvements

In addition to the voxel-based method, there are some other more efficient shape-from-silhouette techniques such as the marching intersections method and the image-based visual hull algorithm.

To get photo-consistent reconstructions a photo hull can be computed using the space carving algorithm. The texture information, reflectance map and shading information of the original statue can also be used to improve the accuracy.