Computer Vision Assignment Nine @ ETH Zurich

Shape From Silhouettes

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1 Shape From Silhouettes Algorithm Overview

Shape from Silhouette is a technique to find and estimate the 3D shape of objects seen from different silhouette images. The 3D shape of the object is usually known as the Visual Hull of the object in question. Also, It is usually applied on static objects or seperatly at each time instant in case of a moving object. This technique uses the intersection of the visual cones of the silhouettes seen by many cameras with different poses. The steps of the algorithm can be summarized in the following.

2 Silhouette Extraction

Different values were tried to find the best threshold to extract the whole silhouette of the object with the least number of holes in the extracted silhouette. The best random value that was tried is 90.

Figure 1: Extracted Silhouette from the last image in the dataset

3 Volume of Interest

A volume of interest need to be defined in order to attempt the construction of the Visual Hull. The best random bounding box that was found is $bbox = [0, -2, -2; 3, 3, 3]$

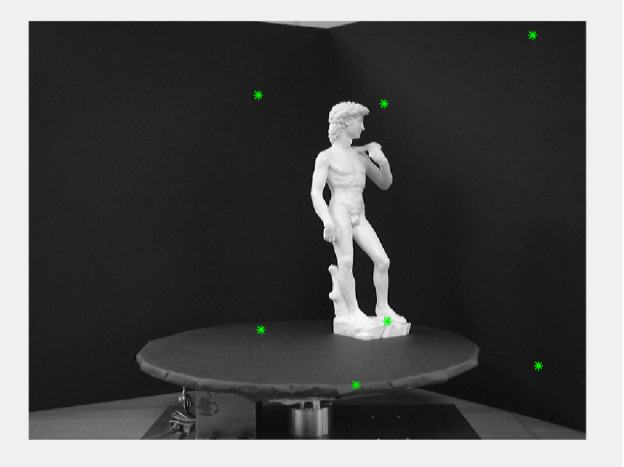
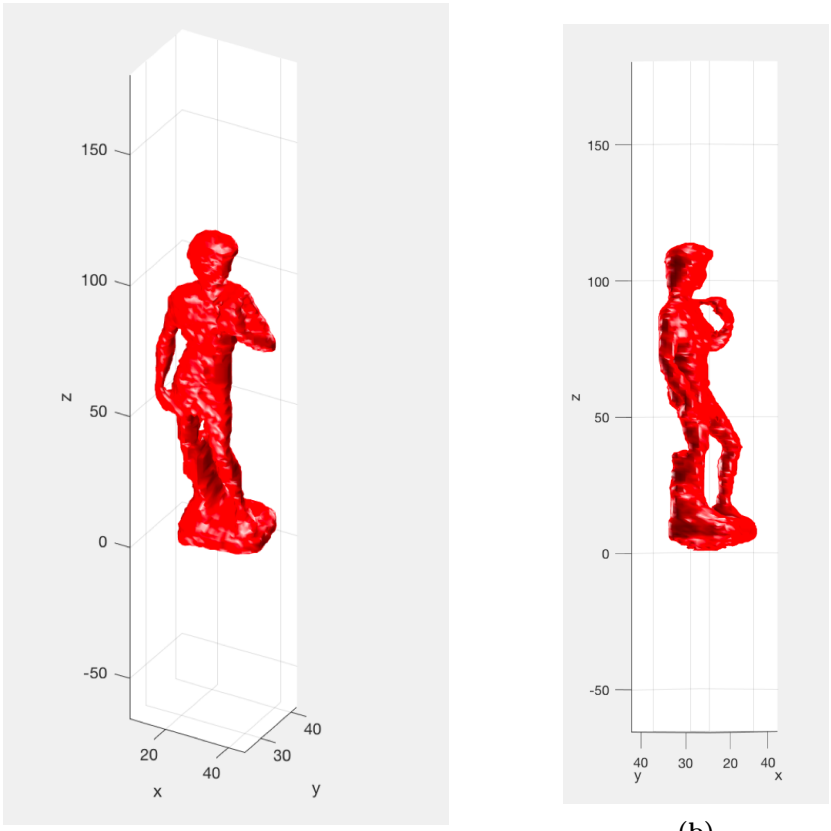


Figure 2: The projection of the volumes shown.

4 Visual Hull

To compute the visual hull, first we project the center of each voxel into each of the images provided. Following that I turn the projected points into a normalized homogenous point, then a check is made if the point actually falls into the silhouette that corresponds to the image in question, if it falls within the bounds then 1 is added.



(a) **(b)**

Figure 3: Reconstructed Visual Hull.

5 Improvments

what is the main drawback of the shape from silhouettes approach?

Figure 4: Not Accurate Extracted Silhouette.

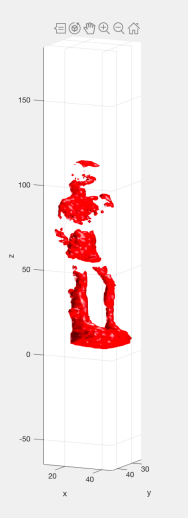


Figure 5: The dependence of the Visual Hall on the quality of the extracted Silhouette.

The main drawbacks of the shape from silhouette method are shown above in Figures 4 and 5. To formalize the drawbacks, one can say that the acquisition space is limited to the intersection of the camera viewing frusta; shape from silhouette methods reconstruct some ghost objects which do not contain real objects, especially when there are multiple real objects in the scene; Lastly, the results depend heavily on the quality of silhouette extraction. [1]

Is there additional information in the images that could be used?

There is more information in the images that can be used for sure. We can extract shadings, colors, occlusions and textures to estimate the depth of the pixels in the images. As shown in a previous assignment, we can also use stereo algorithms to estimate a disparity map, which can then be used to refine the constructed Visual Hull and avoid ghost objects. Also since the resulting visual hull depends highly on the extracted silhouette, we can try different algorithm for silhouette extraction or background subtraction which can increase the accuracy of the visual hull constructed. Also, recently researchers started exploring using deep learning to extract a more accurate silhouette from an image. [2] Moreover, methods used to draw a bounding box around the identified objects in an image, can be used to make sure when constructing the visual hull that the bounding boxes that were used in the images contained the object in question.

6 References

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[1] "Silhouettes Fusion for 3D Shapes Modeling with Ghost Object Removal", Michoud, Guillou, M. Briceno and Bouakaz.
[2] "HS-Nets : Estimating Human Body Shape from Silhouettes with Convolutional Neural Networks", Dibra , Jain , Oztireli , Ziegler and M. Gross.