Detecting and 3D-Modeling of Fountains from Single Image

Şeyma Cengiz, Abdullah Bülbül
Ankara Yıldırım Beyazıt University, Departmant of Computer Engineering

Introduction

In this study, a system is proposed to generate automatically 3D model of detected objects from single image. Firstly, object is detected and labelled on image using convolutional neural networks (CNNs) and GPU acceleration. Then, the object is segmented from background with GrabCut technique. Image is blurred to get certain borders of fountain object and, contours of that are found to create the radiuses of 3D model. Pixel values at each coordinate on these contours are helping us to reach radiuses of 3D model.These radiuses are calculated according to distance between pixel values at x coordinate in left side and center. Finally, a 3D model of the fountain is generated with this information and, it is applied texture to 3D model.

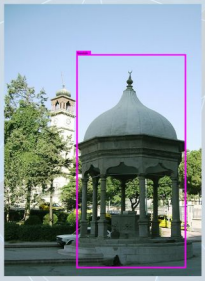
Methods

1. Object Detection

In object detection part, object location is found on given single image by using Convolutional Neural Networks (CNNs) that include both feature extraction and classification was used to get better results.

CNNs include feature extraction function before the normal feed-forward neural network. Computational process of operations is slowly because they involve intensive processing. GPU programming with CUDA is used to speed up operations and so training and testing are faster.

After training the system with CNNs and CUDA, the fountain objects are detected on test images like figure on side.

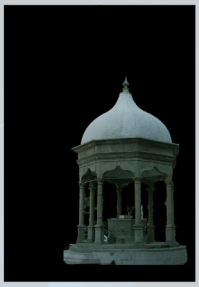


2. Object Segmentation

The fountain object is segmented from background by using GrabCut technique from OpenCV library. GrabCut makes use of both edge and region information.

A Min-cut/Max-Flow algorithm is used to segment the graph. Initially user draws a rectangle around the foreground region.

In this study, the foreground region is determined according to information of detection points from object detection part. Then, we tried to get the best results using the interactive tool of GrabCut.



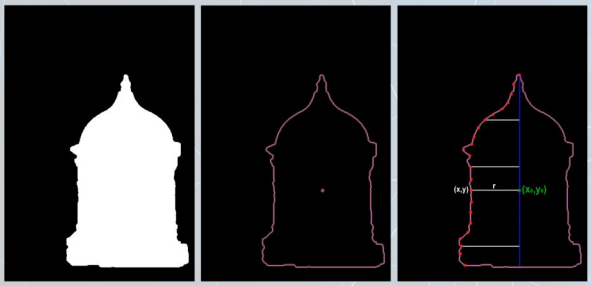
3. Generation of 3D Model

3D model is generated based on contours of image using the output of the segmentation part to model the 3D fountain.

The general pattern of the model is formed by giving approximate radius values from top to bottom according to the structure of the fountain.

For the radius values of model is used distance between the x coordinate of every outer contour in left and center coordinate of fountain.

r_i : the radius of the index-i circle face
x_0 : the centre's coordinate on the drawing
x : the x coordinate on the drawing
$r_i = (x_0 - x)$ where $x < x_0$



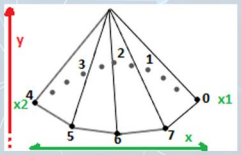
4.Texturing to 3D-Modeling

After the generation of 3D model of the fountain object, it is needed to find a way to relate a 2D image to a 3D model.

In this study, we developed a method to apply the texture coordinates on 3D model.

The texture coordinates are calculated for every corner points of model with in following formula.

The idea of calculation of the texture coordinates (x,y) for the dome of the octagonal sample fountain is shown in following figure.



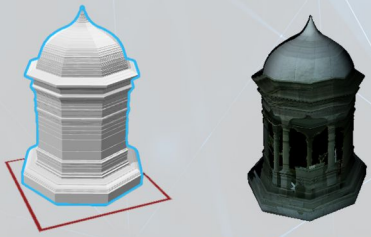
i : index of current corner
x1 : initial corner point
x2 : last corner point
y : current height point
th : rotate with which angle
(tx,ty) : texture coordinates

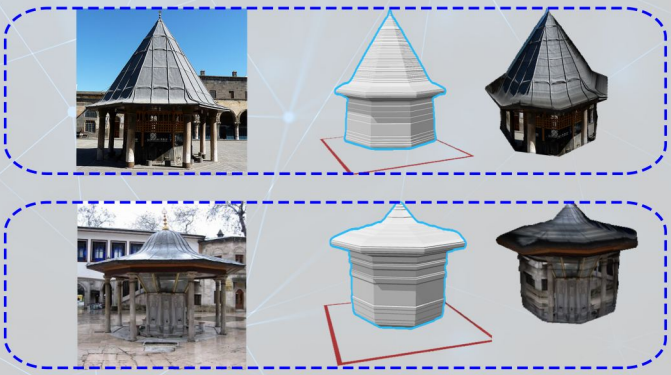
th = 2*pi * i / (numOfTotalCorner)
tx = x1 + (1 - cos(th))*(x2 - x1)/2
ty = y

Implementation & Results

The 3D fountain object is generated by using Trimesh library. Trimesh is a C++ library and set of utilities for input, output, and basic manipulation of 3D triangle meshes.

The texture of each fountain is held in the segmentation part, and it is applied to outside wall of the fountains according to texture coordinates of own fountain images.





Conclusions

In this study, we have proposed a simple way that may be generating a 3D model of fountain object from single image. A 3D model is generated close to its own shape by using this information and is applied a texture to outside wall of the 3D model.

References

Junhua Mao and Lunbo Xu. Automatic 3d reconstruction via object detection and 3d trans-formable model matching. University of California, Los Angeles.

Vittorio Ferrari, Frederic Jurie, and Cordelia Schmid. From images to shape models for object detection. International journal of computer vision, 87(3):284–303, 2010.

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