053 - Computational Methods in Image Analysis

053 - 053 - Session 1: Computational Methods in Image Analysis

No: 144

Title: VOLUMETRIC 3D RECONSTRUCTION AND CHARACTERIZATION OF EXTERNAL ANATOMICAL STRUCTURES FROM IM

Abstract: Three-dimensional (3D) reconstruction and characterization of external anatomical structures from images has been one of the major topics in Computer Vision.

3D models of human external structures are normally built using 3D scanners. Although frequently expensive, they are usually easy to use and can provide 3D models of great accuracy.

Recently, volumetric methods have been successfully used in 3D reconstruction of objects with complex shapes. Comparing with stereo-based methods, they are more efficient in building 3D models of smooth objects. They work in the object volumetric space and do not require a matching process between the images used, which is usually very complex with smooth objects.

The work presented here is based on the Generalized Voxel Coloring (GVC) method. GVC does not impose any restriction on the object's shape or in the camera's displacement. Having as starting point a set of correctly calibrated images, GVC reconstructs the 3D shape of the desired object and colorizes the reconstructed 3D model's surface.

First, in GVC, a 3D volume of voxels surrounding the object to be built is defined. During the reconstruction process, inconsistent voxels are removed (carved). Consistency of a voxel is determined by analyzing the color standard deviation of the pixels that the same reproject in the images used. Finally, with the 3D volumetric model built, it is possible to get a polygonal approach of the object's surface, using, for example, the Marching Cubes algorithm.

In this work, a simple fixed off-the-shelf CCD camera is used. To calibrate it, a planar chessboard pattern is placed in front of the same in different orientations. On this first image sequence, Zhang's method is applied to obtain the camera's intrinsic parameters and radial and tangential distortion coefficients. After that, the object to be reconstructed is placed on a simple turntable device and under it the calibration pattern is positioned. Using again Zhang's method, this configuration allows us to obtain the camera's extrinsic parameters. During the reconstruction process, the intrinsic camera's parameters do not change. Background/object segmentation is performed on all images of the second image sequence, using usual image processing algorithms, like image binarization by threshold value. Having as inputs the second image sequence, the binary images associated and the calibration parameters, GVC is applied to obtain the 3D model for the object to be reconstructed. Finally, the volumetric model obtained is polygonized and smoothed.

Two objects were experimentally used: a hand and a human torso. The camera's calibration parameters were obtained with good precision and the 3D reconstructions built were quite satisfactory as well. Some characteristic measurements were obtained from the models built: volume, centroid, extreme points, etc.

With this work, we can conclude that the building of an accurate 3D model of an external anatomical structure from images is difficult and complex. It was also verified that the errors obtained in the camera's calibration process have a strong influence on the considered reconstruction process. Thus, the future work will be concentrated in the improvement of the camera's calibration method used, as well as in the development of adequate photo-consistency criteria for objects with almost uniform colors on their surfaces, as is the case of human anatomical structures, in order to enhance the 3D models obtained.

Comments: Main References:

Z. Zhang, Determining the epipolar geometry and its uncertainty: a review, Technical report nº 2927, INRIA Sophia-Antipolis, France, 1996.

G. G. Slabaugh, W. B. Culbertson and T. Malzbender, Generalized Voxel Coloring, Workshop on Vision Algorithms, Corfu, Greece, 100-115, 1999.

T. C. S. Azevedo, J. M. R. S. Tavares, M. A. P. Vaz, External Anatomical Shapes Reconstruction from Turntable Image Sequences using a Single off-the-shelf Camera, CompIMAGE - Computational Modelling of Objects Represented in Images: Fundamentals, Methods and Applications, Coimbra, Portugal, 2006.

053 - Computational Methods in Image Analysis

053 - 053 - Session 1: Computational Methods in Image Analysis

Author Information

Lead Tavares, Joao Manuel R. \ Professor \ Instituto de Engenharia Mecânica e Gestão Industrial \ tavares@fe.up.pt
Azevedo, Teresa \ PhD Student \ Faculdade de Engenharia da Universidade do Porto \ meb03012@fe.up.pt
Vaz, Mario \ Prof. \ Faculdade de Engenharia da Universidade do Porto \ gmavaz@fe.up.pt

Session: 053 053 - Session 1: Computational Methods in Image Analysis
Host/Spn: