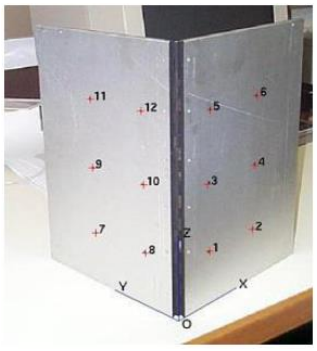
Masters CIMET/3DMT/MLDM - 2016	Practical Exercise IV (3D Reconstruction)	Due date: 10 April 2016

Description:

The objective of this exercise session is to reconstruct a 3D scene, knowing the intrinsic and extrinsic parameters of each camera that the stereovision system used.

Exercise:

For this exercise, one pair of stereo images (stereo1.jpg and stereo2.jpg) is considered. These images show three simple objects and a calibration object placed on a table. The calibration object with the mark XYZ is as follows:

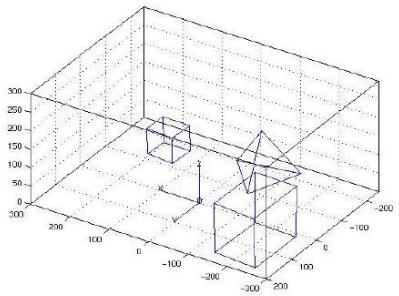


The main file for this exercise is ***Let_me_reconstruction_3D***. At the beginning, you are given a set of corresponding 3D and 2D points in order to perform the calibration. For calibration, Tsai's approach is followed (function ***calibTSAI***) to obtain necessary parameters. Projection matrix is then computed by simple multiplication.

Task 1: Re-project the 3D points into the both 2D images and ensure that calibration parameters are correct.

Task 2:

Once your two calibrated cameras, you know the projection matrices and can reconstruct the scene by triangulation. Our objective in the next task is to obtain a representation like this:



Manually determine the 2 images the coordinates of points you want to rebuild in space, convert camera coordinates using the inverse matrices of the intrinsic parameters, calculate the matrix of global translation and rotation of the stereo vision system. Use the following equations:

$$R = R_r R_l^T$$

$$T = T_l - R^T T_r$$

For every single point, we will perform triangulation. Once you have the 3D points in the camera coordinate system you can apply triangulation. The triangulated 3D point can be obtained by the following equations:

$$P = P_1 + c\left(P_2 - P_1\right)$$

$$P_1 = a_0 p_l \quad P_2 = T + b_0 R^T p_r$$

Here P1 and P2 are the 3D points in the camera coordinate system that you obtained from left and right camera. The coefficients a0 and b0 are obtained by the rays from each camera center and corresponding points. To obtain pl and pr, pixel coordinates must first be converted into homogeneous coordinates and camera coordinates using the inverse of the intrinsic matrices. Your task is to apply appropriate equation to calculate the triangulated point. Consider ***c=0.5*** in your calculation.

Represent the 3D scene. In this task you must do inverse transform with respect to a camera extrinsic calibration parameter (rotation and translation) matrix to obtain the position of the 3D points in the real world coordinate system.