<u>**VISÃO POR COMPUTADOR**</u>
<u>**8 º trabalho**</u>

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Application of homographs

In this work we intend to apply the concepts of homografias induced by planes. Consider the chess pattern images that are attached to this work. The side of each square of the chess is 38 mm. The camera that acquired the images has the following matrix of intrinsic parameters (mm):

$$K = \begin{bmatrix} 2071.82 & 0 & 688.18 \\ 0 & 2070.19 & 571.97 \\ 0 & 0 & 1 \end{bmatrix}$$

1 - Consider the pictures 5, 6 and 7 given. Detect all the corners of the squares (estimating their coordinates) and establish the matches between them. Normalize the coordinates of all corners detected on all images. To do this multiply the coordinates by the matrix K ^ 1

2 - Using the normalized coordinates, compute the homographs between each of the 3D patterns, and their respective images, that is, calculate the matrices H_w^5, H_w^6, H_w^7. Then calculate the homographs between images 5 and 6, 6 and 7, 5 and 7, or calculate the homographs H_5 ^ 6, H_6 ^ 7, H_5 ^ 7, induced by the visible chess plan. Then check that the following equalities are satisfied:

a) $H_5^6 = H_w^6 \times (H_w^5)^{-1}$

b) $H_6^7 = H_w^7 \times (H_w^6)^{-1}$

c) $H_5^7 = H_6^7 \times H_5^6$

Review, comment and discuss the results.

H{1, 3}

	1	2	3
1	1.0032	0.2921	-49.8273
2	-0.2117	1.2763	-17.9565
3	-1.1627e-04	4.4358e-04	1
4			
5			
6			
7			
8			
9			
10			
11			
12			

Command Window

```
ans =

    1.0547    0.3071  -52.3860
   -0.2226    1.3418  -18.8786
   -0.0001    0.0005    1.0513
```

The third equation is verified. The normalized ones are wrong, though which would imply either a mistake or that this solution is not working to computer H5_6 or H6_7.

3 - Make the decomposition in singular values of each of the six calculated homographs. For each of them, divide all its elements by the second largest singular value. The six standard homographs are thus obtained.

4 - Let H_N be each of the normalized homographs. For each one of them calculate the following decomposition in singular values:

$$H_N^T \times H_N = V \Sigma V^T$$

Let be the sigma_1 sigma_2, and sigma_3 the three singular values and [gamma1 gamma2 gamma 3] the three vectors column of the matrix V. Calculate the following vectors u1 and u2:

$$u_1 = \frac{\sqrt{(1-\sigma_3)}\, v_1 + \sqrt{(\sigma_1 - 1)}\, v_3}{\sqrt{\sigma_1 - \sigma_3}} \quad \text{e} \quad u_2 = \frac{\sqrt{(1-\sigma_3)}\, v_1 - \sqrt{(\sigma_1 - 1)}\, v_3}{\sqrt{\sigma_1 - \sigma_3}}$$

Calculate the following matrices:

$$U_1 = \begin{bmatrix} v_2 & u_1 & \widehat{v_2} u_1 \end{bmatrix}, \; W_1 = \begin{bmatrix} H_N v_2 & H_N u_1 & \widehat{H_N v_2}\, H_N u_1 \end{bmatrix}$$

$$U_2 = \begin{bmatrix} v_2 & u_2 & \widehat{v_2} u_2 \end{bmatrix}, \; W_2 = \begin{bmatrix} H_N v_2 & H_N u_2 & \widehat{H_N v_2}\, H_N u_2 \end{bmatrix}$$

Where the symbol ^ represents the antisymmetric matrix obtained with the elements of the respective vector.

5 - Then, for each homography, calculate the four solutions for the rotation of the camera R, translation with scale factor T / d and normal of the plane N. The four solutions are:

Solução 1:

$$R_1 = W_1 U_1^T, \quad N_1 = \widehat{v_2} u_1, \quad \frac{T_1}{d} = (H_N - R_1) N_1$$

Solução 2:

$$R_2 = W_2 U_2^T, \quad N_2 = \widehat{v_2} u_2, \quad \frac{T_2}{d} = (H_N - R_2) N_2$$

Solução 3:

$$R_3 = W_1 U_1^T, \quad N_3 = -\widehat{v_2} u_1, \quad \frac{T_3}{d} = -(H_N - R_1) N_1$$

Solução 4:

$$R_4 = W_2 U_2^T, \quad N_4 = -\widehat{v_2} u_2, \quad \frac{T_4}{d} = -(H_N - R_2) N_2$$

By imposing the restriction that all points must be in front of the camera two of these solutions are eliminated. Analyze and comment on the relationships between the rotations, translations and normal to the plane estimated with the various homographs. Discuss what possible relationships exist between them.