Computer Vision
Exercise Sheet 6

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Exercise 1: Projective Transformation in 2D (10 points)

a) Given two pairs of lines that are parallel to each other.

$$x_1 = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix} \quad , \quad x_2 = \begin{pmatrix} 6 \\ 4 \\ 1 \end{pmatrix} \qquad \text{and} \qquad y_1 = \begin{pmatrix} 2 \\ 5 \\ 1 \end{pmatrix} \quad , \quad y_2 = \begin{pmatrix} 4 \\ 10 \\ 1 \end{pmatrix}$$

Compute the transform matrix that would rectify the image containing them.

Hint: Do you know RECTIFY-AFFINE-TWO-PARALLEL algorithm?

(4 points)

b) Given two pairs of lines that are orthogonal in the origin.

$$x_1 = \begin{pmatrix} 2 \\ 4 \\ 0 \end{pmatrix} \quad , \quad x_2 = \begin{pmatrix} 5 \\ 2 \\ 0 \end{pmatrix} \qquad \text{and} \qquad y_1 = \begin{pmatrix} 1 \\ -2 \\ 0 \end{pmatrix} \quad , \quad y_2 = \begin{pmatrix} -2 \\ 5 \\ 0 \end{pmatrix}$$

Compute the transform matrix that would rectify the image containing them.

Hint: Do you know RECTIFY-METRIC-TWO-ORTHOGONALS algorithm? You can use *numpy.linalg.cholesky* function to find the Cholesky factor of S. You can also find the tutorial about Cholesky factorization in the presentation

`http://www.cs.utexas.edu/~pingali/CS378/2011sp/lectures/chol4.pdf`

(6 points)

Exercise 2: Projective Transformation in 3D (10 points)

a) Find the plane through the three following points

$$X_1 = \begin{pmatrix} 5 \\ 4 \\ 2 \\ 1 \end{pmatrix} \qquad X_2 = \begin{pmatrix} -1 \\ 7 \\ 3 \\ 1 \end{pmatrix} \qquad X_3 = \begin{pmatrix} 2 \\ -2 \\ 9 \\ 1 \end{pmatrix}$$

Hint: Chapter 3 - Projective Geometry and Transformation of 3D (Multiple view geometry in computer vision, Cambridge university press, 2004), page 66 - 67. You can also find the information from the presentation http://www.csc.kth.se/~madry/courses/mvg10/Attachments/02_Presentation01_Ch3_Marianna.pdf

(4 points)

b) Find the point of intersection of the three following planes

$$3x + 5y + z = 2 \qquad 7x + 2y - 4z = -1 \qquad 2y + 5z = -8$$

Hint: Chapter 3 - Projective Geometry and Transformation of 3D (Multiple view geometry in computer vision, Cambridge university press, 2004), page 66 - 68. You can also find the information from the presentation

http://www.csc.kth.se/~madry/courses/mvg10/Attachments/02_Presentation01_Ch3_Marianna.pdf (4 points)

c) Show that a 3D affine transformation makes points at infinity stay at infinity.

Hint: The point transformation is defined as $\mathtt{X}' = \mathtt{HX}$. The ideal points are defined as $(X_1, X_2, X_3, 0)^T$.

(2 points)