16720J: Homework 1 - Planar Homographies

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3 Planar Homographies: Theory (40pts)

3.1 (10pts)

Prove that there exists an $\boldsymbol{H}$ that the satisfies homography equation.
The easiest way to show this is to assume ???. Then the points in the plane are of the form $[\boldsymbol{?\ ?\ ?\ ?}]^{\boldsymbol{T}}$

Therefore, the original equations for $\boldsymbol{p1}$ and $\boldsymbol{p2}$:

$$p_1 \equiv \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \end{bmatrix}_1 \begin{bmatrix} ? \\ ? \\ ? \\ ? \end{bmatrix} \tag{1}$$

$$p_2 \equiv \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \end{bmatrix}_2 \begin{bmatrix} ? \\ ? \\ ? \\ ? \end{bmatrix} \tag{2}$$

can be written as:

$$\ldots \tag{3}$$

...
therefore there exists an $\boldsymbol{H}$ where

$$p_2 \equiv \ldots \equiv Hp1 \tag{4}$$

When does this fail?
...

3.2 (10pts)

Prove that there exists an $\boldsymbol{H}$ that satisfies homography equation given two cameras separated by a pure rotation.

$$p_1 = K_1[I\,0]P$$
$$p_2 = K_2[R\,0]P \tag{5}$$

...

Now you are trying to find that the H exists. It will be a good idea to try to manipulate these expressions in the direction of some expression

$$p_2 \equiv \{\text{your expression here}\}p_1 \tag{6}$$

so

$$H \equiv \text{your clever expression here}\} \tag{7}$$

...

3.3 (5pts)

From Section 3.2

$$H \equiv \text{your clever expression here}\} \tag{8}$$

therefore

$$H^2 \equiv \ldots \tag{9}$$

3.4 (5pts)

Why is the planar homography not completely sufficient to map any arbitrary scene image to another viewpoint?

...

Your thoughts here

3.5 (5pts)

We have a set of points $\boldsymbol{p_1^i}$ in an image taken by camera $\boldsymbol{C_1}$ and points $\boldsymbol{p_2^i}$ in an image taken by $\boldsymbol{C_2}$. Suppose we know there exists an unknown homography $\boldsymbol{H}$ such that

$$\boldsymbol{p_1^i \equiv H p_2^i} \tag{10}$$

Assume the points are homogeneous coordinates in the form $\boldsymbol{p_j^i = (x_j^i, y_j^i, 1)^T}$. For a single point pair, write a matrix equation of the form

$$\boldsymbol{Ah = 0} \tag{11}$$

Where $\boldsymbol{h}$ is a vector of the elements of $\boldsymbol{H}$ and $\boldsymbol{A}$ is a matrix composed of the point coordinates.

...

HINT: we are thinking about the relation

$$\boldsymbol{p_1} \equiv \boldsymbol{H}\boldsymbol{p_2} \tag{12}$$

but we want something in the form $Ax = 0$

Now look at the lecture notes for "things = 0".

Good luck!

4 Planar Homographies: Implementation (30pts)

4.1 (15pts)

...See `computeH.m` for template and hints ...

4.2 (15pts)

a) ...

b) See `create_p1p2.m`

c) See `warp2PNCpark.m`

d) See `q42checker.m` and add the image to this report

LaTeXusers can add the image with the commented code in `report.tex`

5 Panoramas (30pts)

5.1 (15pts)

You're doing great! I think you've got this now.

5.2 (15pts)

You're doing great! I think you've got this now.