Computer Vision LAB#5

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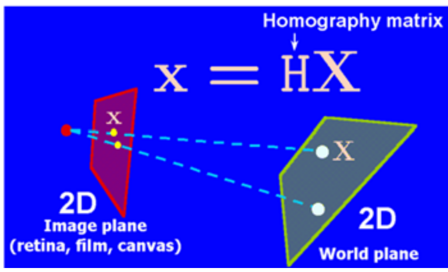
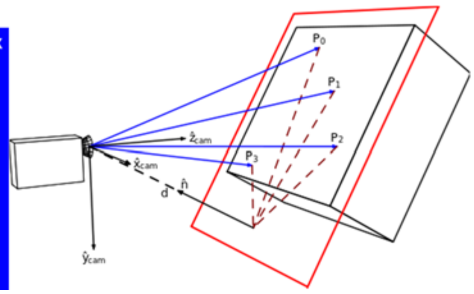
In a central projection camera model, a three-dimensional point in space is projected onto the image plane by means of straight visual rays from the point in space to the optical centre (such as your eye). This process can be described mathematically by a projection matrix P, which takes a point in three-dimensional space and transforms it into a point on the two-dimensional image plane.

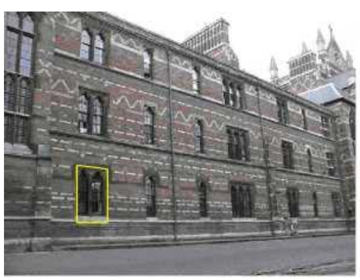
The projection matrix P can be computed from the external and internal camera parameters, such as its position, orientation and focal length.





<u>Plane-to-plane Homography(Homography)</u>

In the case where planar surfaces are imaged, the transformation is called a *plane-to-plane homography* (a simpler matrix H). If the homography between a plane in the scene and the plane of the image (the retina or the canvas) is known, then the image of the planar surface can be rectified into a front-on view.



Original photo Rectified, front-on view

The homography can be computed simply by knowing the relative position of four points on the scene plane and their corresponding positions in the image. For example, the left-hand image above is a photograph of a flat wall of a building taken from an angle. Four corners of a window have been selected, and the homography between the plane of the wall and that of the photograph has been computed by mapping the selected four image points to a rectangle with the same aspect ratio as the window. Thanks to the homography, a new view of the wall (on the right) has been generated as if it was looked at from a front-on position.

IN THE LAB ASSIGNMENT

The basic goal of the Lab was to basically implement the DLT algorithm.

The prosecure adopted was as follows.

Part 1

LAB5_P1.m

1. Manually deifine four coordinates of a square and make them homogenous by adding 1. Stack them into a 4X3 matrix X1.
2. Define a Known Transformation (T) e.g Roto Translation with TX and TY =1.
3. Compute X2 by X1*T.

my_homography.m

1. Takes to arguments X1 and X2.
2. Computes A the 8X9 full rank matrix by below

$$\begin{bmatrix} \mathbf{0}^\top & -w'_i\mathbf{x}_i^\top & y'_i\mathbf{x}_i^\top \\ w'_i\mathbf{x}_i^\top & \mathbf{0}^\top & -x'_i\mathbf{x}_i^\top \end{bmatrix} \begin{pmatrix} \mathbf{h}^1 \\ \mathbf{h}^2 \\ \mathbf{h}^3 \end{pmatrix} = \mathbf{0}$$

$$Ah = 0$$

3. Compute the null space matrix(H) by using SVD and Reshape function.

Part 2

LAB5_P2.m

1. Load the image as I1.
2. Select 4-points , make them homogenous and stack them in a matrix X1.
3. Select 4 points of virtual image , make them homogenous and stack them in a matrix X2.
4. Calculate H by calling my_homography.m
5. Calacuate the difference.
6. See results by forward and then Backward warping(using Bileaner interpolation)

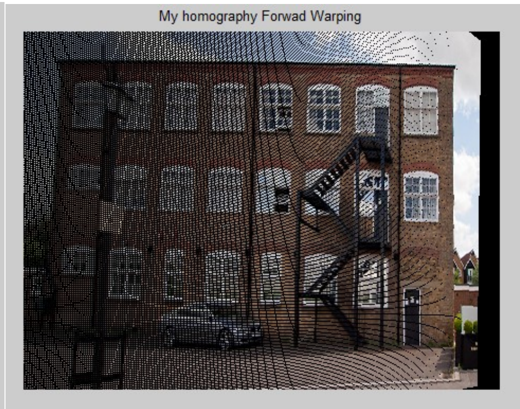
```
% Apply Homography forward warping
[I2] = forward_warp(I1,H);

% Apply Homography backward warping with biliner interpolation
[I2] = back_warp(I1,H);
```

RESULTS

Orignal Image

Applying Homography (Forward Warping)



Applying Homography(Reverse Warping)