Département de génie électrique
Faculté des sciences et de génie

Vision numérique
GIF-4100 / GIF-7001

Mid-term exam A 2012

QUESTION 1 (20 points au total) Perspective Projection - Vanishing Points.

A transparent cube is observed from different viewpoints by a pinhole camera.

A) (7 points) For a viewing direction (i.e. optical axis of the pinhole) aligned with a principal diagonal of the cube, how many vanishing point do you observe? Explain your answer by a diagram.

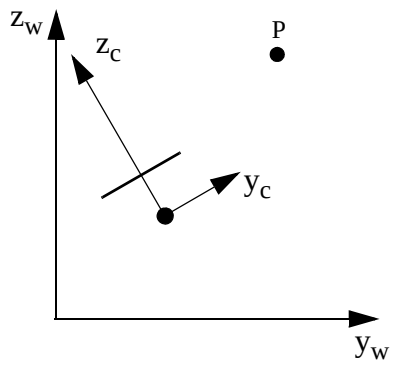
B) (7 points) For a viewing direction (i.e. optical axis of the pinhole) perpendicular to a face of the cube, how many vanishing point do you observe? Explain your answer by a diagram.

C) (6 points) For a viewing direction (i.e. optical axis of the pinhole) perpendicular to an edge of the cube, how many vanishing point do you observe? Explain your answer by a diagram.

QUESTION 2 (points au total) Frame transformations and perspective projection.

A pinhole camera with focal distance 10 cm, initially aligned with the world reference frame (x_w-y_w-z_w) (x_w axis normal to the sheet and coming out of it) is submitted to a translation of *1 m* along y and *1 m* along z and is then rotated by +30° (i.e. counterclockwise) around the x axis of the resulting coordinate frame (following the translation) (remember that the x axis is normal to the page and coming out of it). This rotation leads to camera reference frame (x_c-y_c-z_c) (see Figure 1).

Figure 1 Geometry for Question 2



A) (15 points)

Write the matrix equation in homogeneous coordinates allowing to compute the coordinates in the reference frame of the camera of a point P with coordinates x_{wp}, y_{wp}, z_{wp} in the world reference frame.

B) (5 points)

Using the matrix found in A , what are the image coordinates (in the camera reference frame) of point P=(0 m, 2 m, 2.5 m) in the world reference frame?

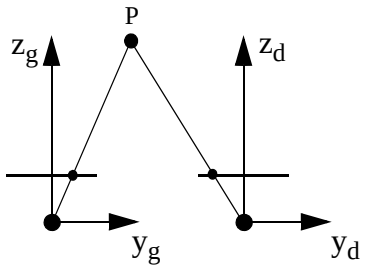
QUESTION 3 (20 points) Stereo reconstruction

Let us assume the two pinholes with focal *10 cm* shown in Figure 2. The pinhole on the left ("g") is considered as the world reference frame. The pinhole on the right ("d"), which was initially aligned with pinhole "g", has been translated by *(0 m, 2 m, 0 m)* with respect to pinhole "g".

The image coordinates of a point P in the world reference frame are (x_{ig},y_{ig},z_{ig}) = (0 m, 0.033 m, 0.1 m) in the reference frame of pinhole "g" and (x_{id},y_{id},z_{id}) = (0 m, -0.033 m, 0.1 m) in the reference frame of pinhole "d".

Computre the coordnates of point P in the reference frame of pinhole "g". Explain your methodology for computing P.

Figure 2 Geometry of the problem in Question 3.



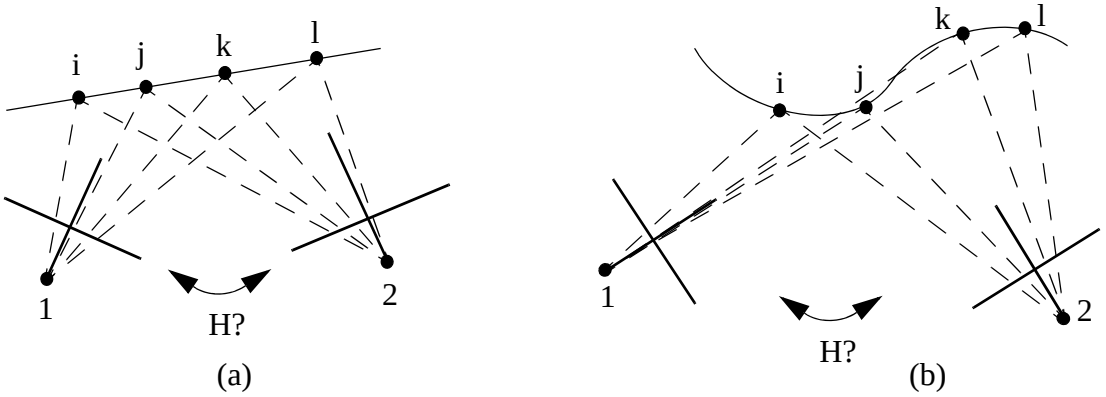
QUESTION 4 (20 points)

Explain the procedure for calibrating a pinhole camera for estimating the intrinsic and extrinsic parameters. Radial distorsion can be neglected.

QUESTION 5 (20 points au total) Homographies

Let us assume the geometry in Figure 3. below.

Figure 3 Geometry for Question 5



A) (10 points) Is it possible to compute the homography between the images given by pinholes observing

points i-j-k-l on the plane in (a)? Justify your answer.

B) (10 points) Is it possible to compute the homography between the images given by pinholes observing points i-j-k-l on the surface in (b)? Justify your answer.