

Homework #1

Due time: 2:20pm, Wednesday, Jan 25

1. Show that, in the pinhole camera model, the images of a set of parallel lines on a plane intersect at a single vanishing point on the image plane. (20 pts)
2. Prove that the vanishing points associated with three coplanar bundles of parallel lines are collinear. (20pts)
3. Given the image in Fig. 1, prove the cross-ratio of 4 points on a line $(A, B; C, D) = \frac{AC}{BC} \frac{AD}{BD}$ is preserved under perspective projection. Hints: you can use the parametric form to represent a line. (20pts)

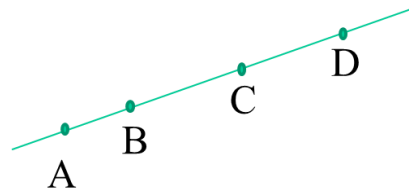


Figure 1

4. Show that the rotation matrix \mathbf{R} will change if the order of rotations about coordinate axes changes. Hints: you need to prove $\mathbf{R} = \mathbf{R}_z \mathbf{R}_y \mathbf{R}_x$ is not equal to $\mathbf{R}' = \mathbf{R}_x \mathbf{R}_y \mathbf{R}_z$. (20pts)
5. Use the perspective projection equations to explain why, in a picture of a face taken frontally and from a very small distance to the camera, the nose appears much larger than the rest of the face? How can you reduce this effect? Why? (20pts)