

**ECE 5397/6397: Intro to Robotics**

**Class Handout –Lecture 15**

1. ­For a camera with focal length , find the image plane coordinates for the 3D points whole coordinates in the camera frame are given below. Indicate which points will not be visible to a physical camera.

Transformation:

* 1. (25,25,50)c 🡪 (*u,v*) =

* 1. (-25,-25,50)c 🡪 (*u,v*) =

* 1. (20,5,-50)c 🡪 (*u,v*) =

* 1. (15,10,25)c 🡪 (*u,v*) =

* 1. (0,0,50)c 🡪 (*u,v*) =

* 1. (0,0,100)c 🡪 (*u,v*) =

1. Repeat for the case where coordinates of points given with respect to the world frame. Suppose the optical axis is aligned with the world x-axis, the camera x-axis is parallel to the world y-axis, and the center of projection has coordinates (0,0,100).
   1. (25,25,50)w 🡪 ( )c 🡪 (*u,v*) =

* 1. (-25,-25,50)w 🡪 ( )c 🡪 (*u,v*) =

* 1. (20,5,-50)w 🡪 ( )c 🡪 (*u,v*) =

* 1. (15,10,25)w 🡪 ( )c 🡪 (*u,v*) =

* 1. (0,0,50)w 🡪 ( )c 🡪 (*u,v*) =

* 1. (0,0,100)w 🡪 ( )c 🡪 (*u,v*) =

1. A stereo camera system consists of two cameras that share a common field of view. By using two cameras, stereo vision methods can be used to compute 3D properties of the scene. Consider stereo cameras with coordinates frames and such that

Here, is called the **baseline distance** between the two cameras. Suppose that a 3D point *P* projects onto these two images with the image plane coordinates in the first camera and in the second camera. Determine the depth of the point *P*

1. Consider two parallel lines in 3D, given parametrically by

, where is a unit vector, , and is a point on the line. Show that if two lines are parallel, that is, if , then the projection of these two lines in an image intersect at a single point. This point is called the **vanishing point**

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Lesson 1:

Lesson 2:

1. Show that the vanishing points for all 3D horizontal lines must lie on the line of the image plane.
2. Suppose the vanishing point for two parallel lines has the image coordinates .Show that the direction vector for the 3D line is given by

, in which is the focal length of the imaging system.

unit vector implies that

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**Class Worksheet – Preparation for Lecture 16**

Two parallel lines define a plane. Consider a set of pairs of parallel lines such that the corresponding planes are all parallel. Show that the vanishing points for the images of these lines are collinear. Hint: let be the normal vector for the parallel planes and exploit the fact that for the direction vector associated to the line.