Computer Vision
Quiz 2 - Feb 12, 2015

Maximum score: 30 **Time: 30 mins**

Name: ______________________________ Roll No: ______________

1. (*10 points*) State the number of degrees of freedom for the camera motion and the corresponding variables in each of the following cases.

a) A fixed focal length camera rigidly mounted on a robot moving on a planar surface.

b) A constant focal length camera installed on a car running on Delhi roads.

c) A pan-tilt-zoom surveillance camera.

Solution:

a) 3 dof, one for rotation and two for translation.

b) 6 dof, 3 for rotation and 3 for translation.

c) 3 dof, two for rotation and one for zoom (focal length).

2. (*10 points*) Given a point $\mathbf{x} = [x, y, 1]^\top$ on the image plane. What is the set of lines that pass through this point? Write the expression in homogeneous coordinate representation and give the geometric interpretation of this set.
Solution: A line $\mathbf{l} = [l_1, l_2, l_3]^\top$ that passes through $[x, y, 1]^\top$ is a 3-vector satisfying $\mathbf{l}^\top\mathbf{x} = 0$, i.e., $\mathbf{l}$ is orthogonal to the vector $\mathbf{x}$. Therefore the set of lines that passes through points are the lines lying in the 3D plane with the normal $\mathbf{x}$.

3. (*10 points*) Given a 3D rotation matrix $\mathbf{R}$, how would you find the rotation angle? Which points are invariant to this rotation? How are these invariant points related to the eigenvectors of $\mathbf{R}$.
Solution: $\theta = \arccos((trace(\mathbf{R})-1)/2)$. The points invariant to the rotation are the ones that lie along the axis of rotation. The axis of rotation is given by the eigenvector of $\mathbf{R}$ that has a corresponding eigenvalue of 1.

4. (*10 points*) *Extra credit:* Given a vector $\mathbf{x}$ and a line with normal $\widehat{\mathbf{n}}$ in 2D, write the transformation matrix $\mathbf{T}$ that would perform a reflection operation about the line given by $\widehat{\mathbf{n}}$. *Hint:* What would the transformation be if the line is the y-axis and the vector is along the x-axis? Now generalize.
Solution: The reflection matrix is given by $\mathbf{T} = \mathbf{I} - 2\widehat{\mathbf{n}}\widehat{\mathbf{n}}^\top$.