**CS 558, Fall 2019, Quiz 3**

**NAME:**

**Problem 1.** Explain a) WHY after applying a mean filter, the maximum intensity of an image cannot increase? b) WHEN does the maximum stay the same after filtering? The filter is square ($n \times n$), all weights are equal and they sum to 1.

**Problem 2.** a) WHY should image gradient estimation be performed over a pre-smoothed image? b) HOW can differentiation and smoothing be performed at the same time?

**Problem 3.** Let $\mathbf{A} = [A]_{ij}$ be $3 \times 3$ diagonal matrix with $A_{ii} = i$ and $\mathbf{p} = (x, y, z)^\top$ be a vector. Write the expression for the quadratic form $\mathbf{p}^\top \mathbf{A} \mathbf{p}$

**Problem 1.**
**A) average is never greater that the maximum element in a set.**
**B) When all points have the same intensity**

**Problem 2.**
**A) To reduce sensitivity to noise**
**B) By combining a pair of convolutional filters into a single one through composition (i.e. aplying one filter to the other after adding zeros for padding)**

**Problem 3.**
**x*[A_11*x+A_12*y+A_13*z]+y[A_21*x+A_22*y+A_23*z]+z*[A_31*x+A_32*y+A_33*z] = A_11*x^2 + A_22*y^2+A_33*z^2+(A_12+A_21)*xy+(A_13+A_31)*xz + (A_23+A_32)*yz**

CS558 - Quiz 4

Student Name: _____

1.- Choosing between the second moment matrix and the Hessian matrix, which one would be more efficient to estimate? Explain your reasoning.

**Second moment matrix only considers the derivatives Ix and Iy**
**Harris requires "mixed" derivatives Ixy as well as the second derivatives Ixx and Iyy**

2. How is detecting a "corner" feature different than a "blob" feature?

**Corners are a function of the second moment matrix**
**Blobs require finding an extrema of scale-space analysis (i.e. Laplacian of DoG filters)**

CS558 - Quiz 5

Student Name: _____

1.- Consider you have a laser scan of a room (consisting of a million unique 3D points). You want to fit a 3D plane model to the attained point cloud. Assume you only need 3 different points to define a single plane hypothesis, and that 50% of the data are contained within the desired plane. What is the probability of finding the correct plane after 2 RANSAC iterations? (Fractional answers are sufficient)

**e=0.5** **probability of outlier sample**
**1-e** **probability of inlier sample**
**(1-e)^3** **probability of a model sample comprised only of inliers**
**1-(1-e)^3** **probability of a model sample containing at least one outlier**
**(1-(1-e)^3)^2** **probability of both model samples containing at least one outlier**
**1-(1-(1-e)^3)^2** **probability of both at least one model sample comprised only of inliers**

2. Consider a 2D point in the plane with coordinates *(x=3,y=2)*. Considering the polar representation of a line, what are the values of rho for the following scenarios:

a) A vertical line **rho=3**
b) A horizontal line **rho=2**
c) A line with theta equal to 45 degrees **rho=sqrt(1.5)**

CS558 - Quiz 6

Student Name: _____

1.- Consider a 2D rotation matrix operating on a 2D point (x,y), is there a point which after being pre-multiplied by the rotation matrix remains constant? Explain

**The point at the origin (0,0) will not be moved**

**A rotation will not change the norm a vector, the only vector with zero norm is the origin**

2.- Consider a 2D point in homogeneous coordinates (x,y,1), write a single linear operation matrix operation that yields the 2D vector (3x+5,4y+6) in non-homogeneous coordinates. Howwould your matrix change if you were required yo generate the output in homogeneous coordinates?

**Matrix in non-homogeneous coordinates**

$$\begin{matrix} 3 & 0 \\ 0 & 4 \end{matrix} * \begin{matrix} x \\ y \end{matrix} + \begin{matrix} 5 \\ 6 \end{matrix}$$

**Matrix in homogeneous coordinates**

$$\begin{matrix} 3 & 0 & 5 \\ 0 & 4 & 6 \end{matrix} * \begin{matrix} x \\ y \\ 1 \end{matrix}$$