First Test for Computer Vision (E1.216)
16 February 2022

Notes

- The duration of this exam is 2 hours
- You **must** begin an answer on a new page. Failure to do so will incur penalties
- You will be graded for clarity and brevity of your solutions

Question 1

a Prove that affine transformations preserve parallelism. [2 points]

b Justify the definition of the median value of a set of scalars $\{x_1, \cdots, x_n\}$ [4 points]

c In SIFT, justify the use of σ^2 in the LoG operator $\sigma^2 \nabla^2(G)$ [4 points]

Question 2

Sketch the iso-contours for the Harris corner strength function for $\alpha = \frac{1}{2}$. Give a succinct justification. [10 points]

Question 3

Consider a plane in front of an ideal pin-hole camera. Let a 3D point on the plane be denoted $\mathbf{P} = [X, Y, Z]^T$ and the corresponding image projection be (x, y). Further, let the normal of the plane be parallel to the optical axis of the camera. Derive a relationship that is satisfied by all observed image points $\{(x_1, y_1), \cdots, (x_n, y_n), \cdots\}$. [10 points]

Question 4

Let us consider a unit sphere with uniform albedo of $\rho = 1$. Let it be lit by a point source at infinity and let the corresponding image be I_1. Now let this light source be rotated by an unknown angle ω and let the new image of the sphere be I_2. Propose a method to estimate $||\omega||$ given the images I_1 and I_2. [10 points]

Question 5

Let us consider a homography or projective transformation between point correspondences in two cameras, i.e. $\mathbf{q} = \mathbf{H}\mathbf{p}$ where $\mathbf{p}$ and $\mathbf{q}$ are the homogeneous forms of points (x_1, y_1) and (x_2, y_2) respectively. Develop a RANSAC procedure for identifying outliers in this scenario. [10 points]
NOTE: Simply giving me the standard RANSAC procedure will not earn you any credit. I want to see if you understand what is specific to this problem.