

Exercises in 3D Computer Vision

Exercise 25 **Harris Corner Detector**

The Harris Corner Detector is a popular method for extracting salient image points. One desirable property for a corner detector is that it is invariant to affine illumination changes. In this exercise we will show that this is true for the Harris Corner Detector.

The Harris measure is defined as

$$c_{Harris}(x,y) = \det(C(x,y)) - k \cdot \text{trace}(C(x,y))$$

with $k = \text{const.}$.

The Noble measure is defined as

$$c_{Noble}(x,y) = \frac{\det(C(x,y))}{\text{trace}(C(x,y))}$$

- a.) Show that the Harris corner detector is invariant to affine illumination changes when using the Noble measure.
- b.) Is the same true for the Harris measure?

Exercise 26 **Normalized Cross Correlation**

The Normalized Cross Correlation (NCC) is a similarity measure for comparing images. Even though it is not rotation and scale invariant it is invariant to affine illumination changes.

The NCC is defined as

$$NCC(I_1, I_2) = \frac{\sum_{\mathbf{x}} (I_1 - \mu_1)(I_2 - \mu_2)}{N_1 N_2 \sigma_1 \sigma_2}$$

where I_1 and I_2 are the two input images with N_1 and N_2 pixels, mean intensity μ_1 and μ_2 and intensity standard deviation σ_1 and σ_2 respectively.

- a) Given a signal X with mean μ and standard deviation σ , compute the sample mean and the sample standard deviation of $Y = \alpha X + \beta$.
- b) Using the results from a), show that the NCC is invariant to affine illumination changes.
- c) Is the NCC always defined?

Exercise 27 **Image Stitching**

Image Stitching by warping only works when the images are related by a homography. In this exercise we will look at two scenarios when this assumption holds.

- a.) Show that two images which were created only by rotating the camera around the optical center are related by a homography.
- b.) Show that the projection of a world plane into an image is always related by a homography under any camera movement.