SURF

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1 Introduction

1. Interest points are selected at distinctive locations in the image, such as corners, blobs, and T-junctions.

2. The neighbourhood of every interest point is represented by a feature vector.

3. The descriptor vectors are matched between different images.

We focus on scale and in-plane rotation-invariant detectors and descriptors.

2 Detectors

The most valuable property of an interest point detector is its repeatability, i.e, the reliability of a detector for finding the same physical interest points under different viewing conditions.

Integral images

Integral images allow for fast computation of box type convolution filters. Once the integral image has been computed, it takes three additions to calculate the sum of the intensities over any upright, rectangular area.

$I_{\sum}(\bar{x}) = \sum_{i=0}^{i \leq x} \sum_{j=0}^{j \leq x} I(i, j)$

Hessian Matrix

We detect blob-like structures at locations where the determinant is maximum.

Given a point $\bar{x}$ in an image I the Hessian matrix $H(\bar{x}, \sigma)$ in $\bar{x}$ at scale σ is defined as follows

$$H(\bar{x}, \sigma) = \begin{bmatrix} L_{xx}(\bar{x}, \sigma) & L_{xy}(\bar{x}, \sigma) \\ L_{xy}(\bar{x}, \sigma) & L_{yy}(\bar{x}, \sigma) \end{bmatrix}$$

where $L_{xx}(\bar{x}, \sigma)$ is the convolution of the gaussian second order derivative $\frac{\partial^2}{\partial x^2} g(\sigma)$ with the image I in point $\bar{x}$

3 Descriptors

The descriptor has to be distinctive and at the same time robust to noise, detection displacements and geometric and photometric deformations.

4 Matching

The matching is based on a distance between the vectors, e.g. the Mahalanobis or Euclidean distance. The dimension of the descriptor has a direct impact on the time this takes, and less dimensions are desirable for fast interest point matching. However, lower dimensional feature vectors are in general less distinctive than their high-dimensional counterparts.