**Lecture 8: Feature Descriptor**

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* Feature Descriptor

Most features can be thought of as templates, histograms (counts), or combinations. And the ideal descriptor should be robust, distinctive, compact and efficient. Most descriptors focus on edge and gradient information.

* Scale Invariant Feature Transform (SIFT) descriptor

Harris corner detector is robust against shift/rotation transformations and brightness changes but is not robust against scale changes. In this point, scale-controllable kernel like LoG and Blob detector can be used well. Using LoG or Blob detector, we can find corresponding patch sizes for automatic scale selection.

If Laplacian of Gaussian(LoG) applied on Edge, it is going to be ripple. And if LoG applied on pulse, it is going to be blob. Convolving with a pulse signal, 1-D LoG generates an extremal pulse when its sigma matches the width of the pulse. It can be clue to find optimal patch sizes. And we need to scale normalization for LoG. It is approximately replaced to (k-1)x(Difference of Gaussian).

SIFT has several steps for feature descriptions. At first, we have to detect the candidates of interest points, which are extrema points in the scalespace domains. Second, Sub-pixel localization and removal of extrema points with low contrast. And then delete edge-like features by calculating the curvature. Third, let’s do orientation assignment using 16X16 window. Finally, descriptor construction.

* Speeded Up Robust Features (SURF) descriptor

Actually, SIFT is one of the best but slow. SURF describes image 3 times faster than SIFT using integral images that is approximately same to LoG or DoG for an efficient implementation. SURF integrates the gradient information within a subpatch, whereas SIFT depends on the orientations of the individual gradients. This makes SURF less sensitive to noise.

* Feature Matching

Nearest neighbor matching is matching one feature to another if those features are nearest neighbors, and their distance is below some threshold. But threshold is difficult to set. And non-distinctive features could have lots of close matches, only one of which is correct. Simple solution could be cross-checking technique or refining matched points using threshold ratio of nearest to 2nd nearest descriptor.