

Kernel Descriptors for Visual Recognition



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- ◆ **Orientation histograms (*e.g.* SIFT) are most successful in recognition**
- ◆ **A kernel view of features casts SIFT as a match kernel over patches**
- ◆ **Kernel Descriptors (KDES)**
 - **A principled way to design rich features to capture various visual attributes (*e.g.* using gradient, color and binary shape)**
 - **Learn **compact features** from match kernels via kernel approximation**
 - **Outperform SIFT and other sophisticated feature learning methods**
Scene-15: 86.7%; Caltech101: 76.4%; CIFAR10: 76.0%

Novelty:

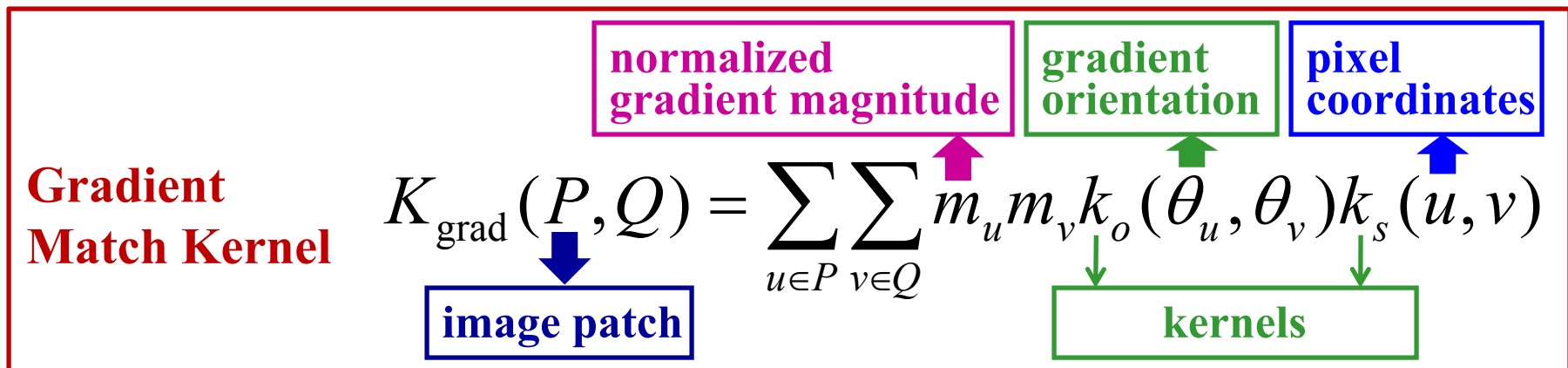
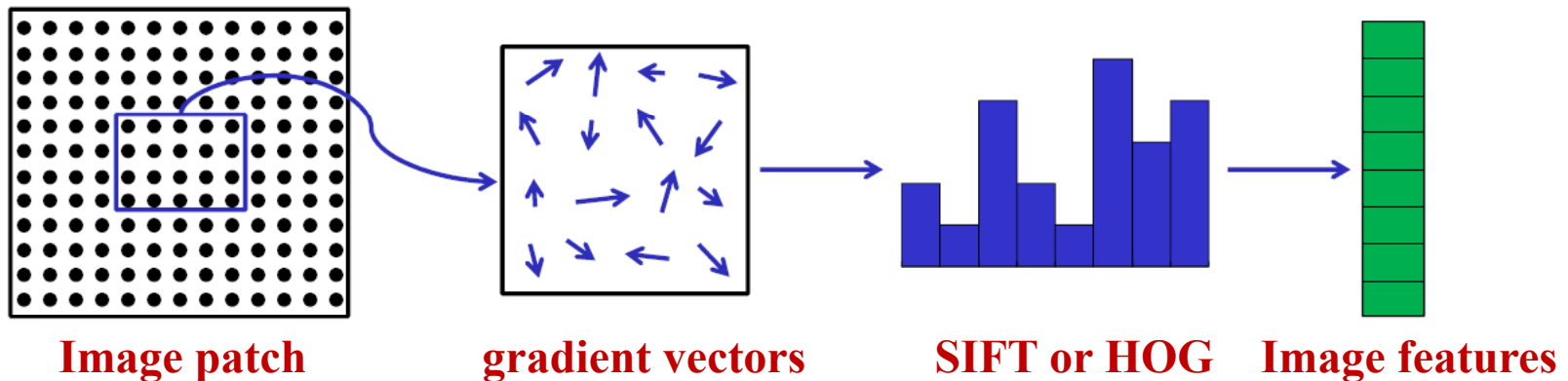
The first work on kernel-based
low-level visual feature learning



Poster ID
T40

Match Kernels over Image Patches

Most visual recognition systems are based on SIFT and HOG



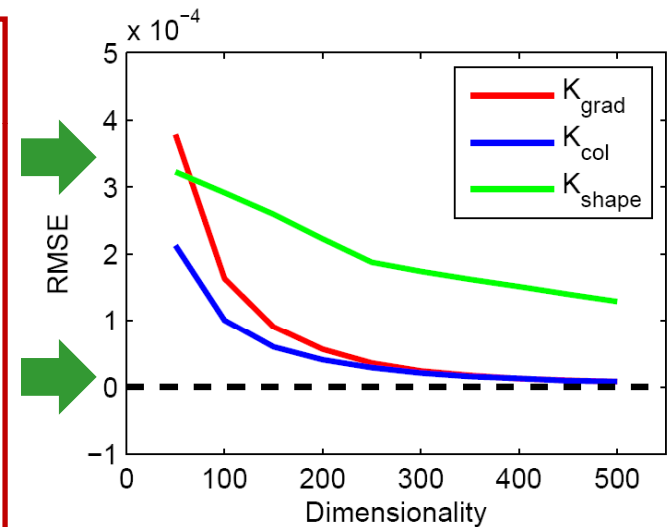
- ✓ Includes SIFT and HOG as special cases;
- ✓ Avoid binning involved in SIFT or HOG;
- ✓ Makes it “easy” to design other match kernels:
pixel values → color match kernel; local binary pattern → shape match kernel.

Kernel Descriptors

Why Kernel Descriptors? (1) explicit low-dimensional visual features
(2) efficient computation and storage

- ① Uniformly and densely sample sufficient basis vectors to guarantee accurate approximation to match kernels;
- ② Learn explicit low-dimensional features based on sampled set using kernel principal component analysis (KPCA).

***task-independent; **accurate approximation**

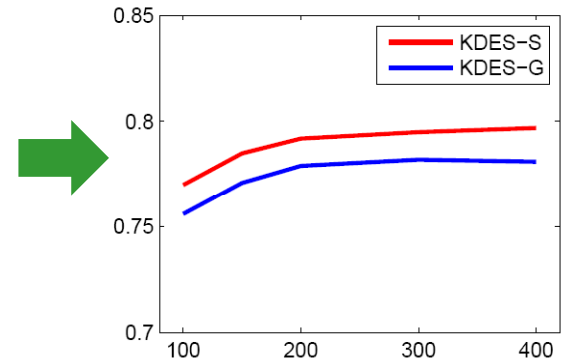


Gradient Kernel Descriptor

$$F_{grad}^t(P) = \sum_{i=1}^{d_o} \sum_{j=1}^{d_p} \alpha_{ij}^t \sum_{u \in P} m_u k_o(\theta_u, x_i) k_s(u, y_j)$$

Experiments

- Free parameters in kernel descriptors are optimized on a subset of ImageNet.
- The resulting values are fixed in the following experiments.



Scene-15

KDES: 86.7%
SIFT: 82.2%

Caltech-101

KDES: 76.4% **CDBN^[2]:** 65.5%
SPM^[1]: 64.4% **LCC^[4]:** 73.4%

CIFAR10

KDES: 76.0% **LCC^[4]:** 74.5%
mcRBM-DBN^[3]: 71.0% **TCNN^[5]:** 73.1%

- [1] Lazebnik, Schmid, Ponce, CVPR '06 [2] Lee, Grosse, Ranganath, Ng, ICML '09
[3] Ranzato, Hinton, CVPR '10 [4] Yu, Zhang, ICML '10
[5] Le, Ngiam, Chen, Chia, Koh, Ng, NIPS '10