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Dimension Reduction for SIFT descriptors to improve matching efficiency

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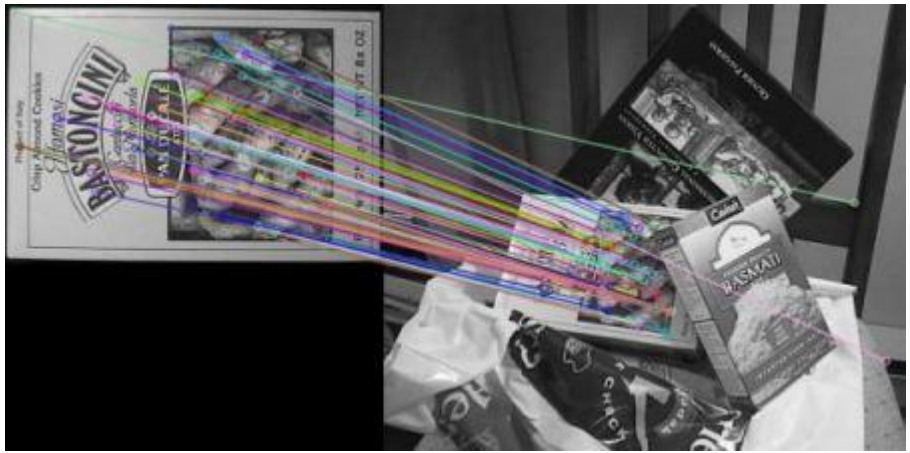
SIFT (Scale-Invariant Feature Transform)

- Scale space peak selection
- Key point localization
- Orientation Assignment
- Key point descriptor



Key point descriptor

- Create a set of orientation histograms on 4x4 pixel neighborhoods with 8 bins each.
- Histograms are computed from magnitude and orientation values of samples in a 16 x 16 region around the key point.

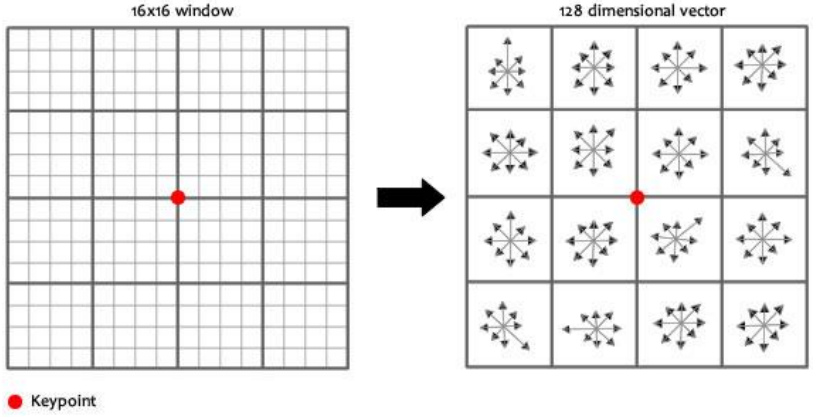
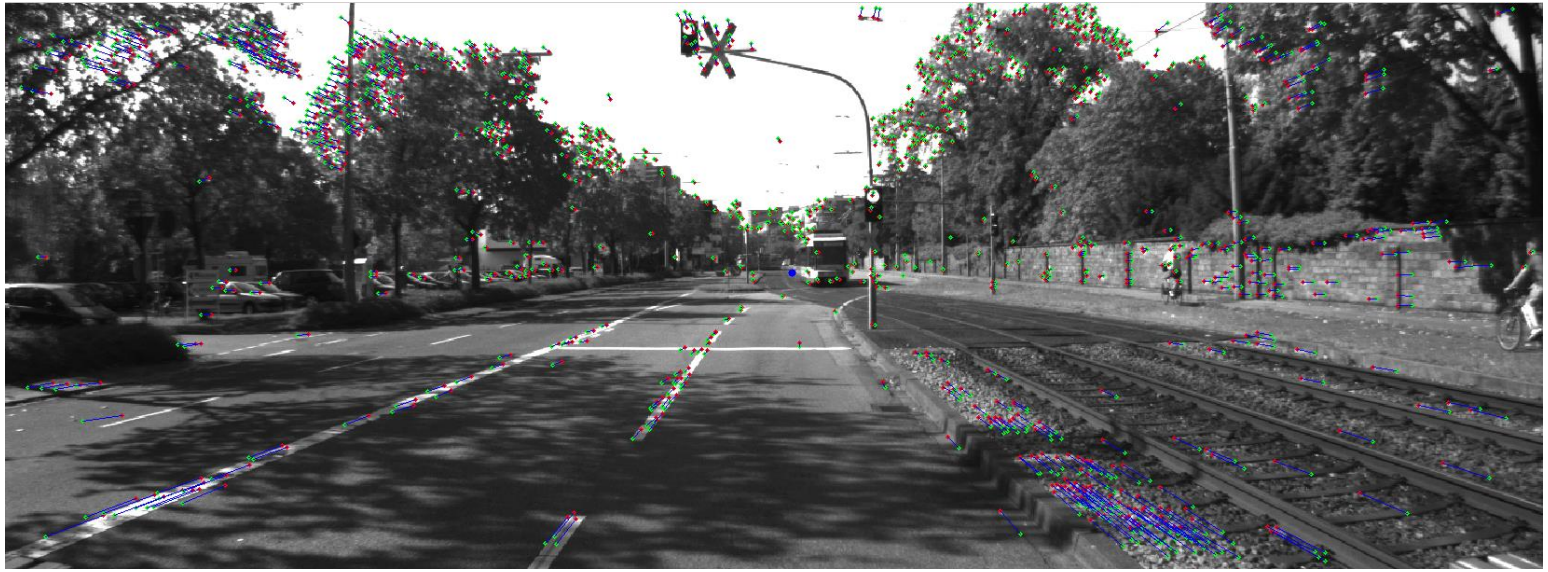


Image Matching



SIFT-HHM

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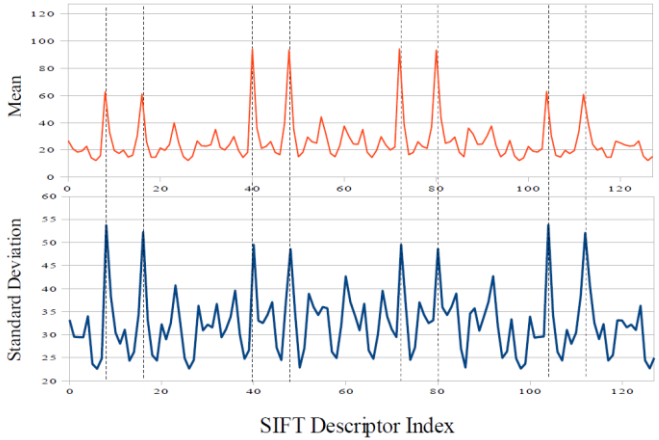
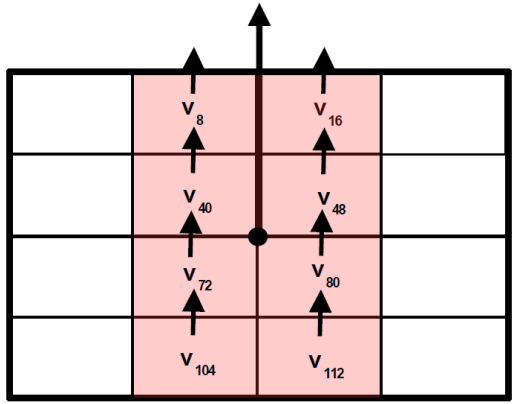
- 8 mean and standard deviation peaks
- Corresponding descriptor vectors are in line with key point's orientation





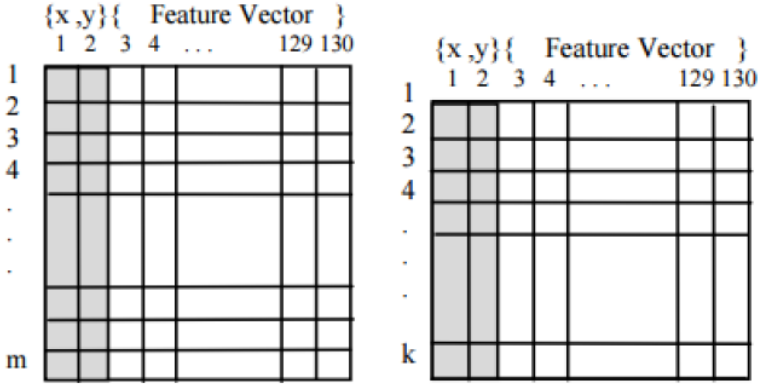
Euclidean Distance Vs Inner Product

- The original matching method in SIFT is calculating the smallest and second smallest Euclidean distance between two vectors. If the distance_1/distance_2 is smaller than a threshold such as 0.8 or 0.65, we will mark the pair as a good match pair.

$$L_o = \sqrt{\sum_{i=1}^{n} \left(x_i - y_i\right)^2}$$

$$P = x_1 * x_1' + x_2 * x_2' + x_3 * x_3' + \ldots + x_{128} * x_{128}'$$

SIFT



$$P = M \cdot K^T$$

$$Recall = \frac{Correctmatchesretrieved}{Totalnumberofcorrectmatches}$$

$$1 - Precision = \frac{Incorrectmatchesretrieved}{Totalofmatchesretrieved}$$

Feature Selection

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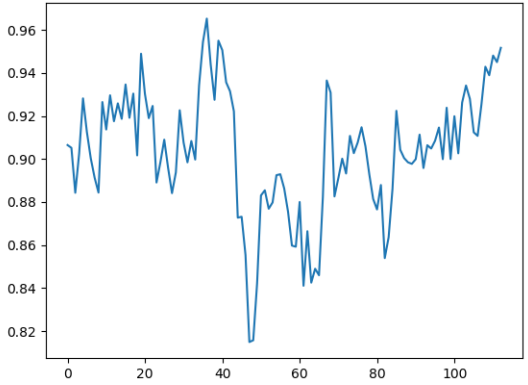
Unsupervised

- Variance Threshold
- PCA

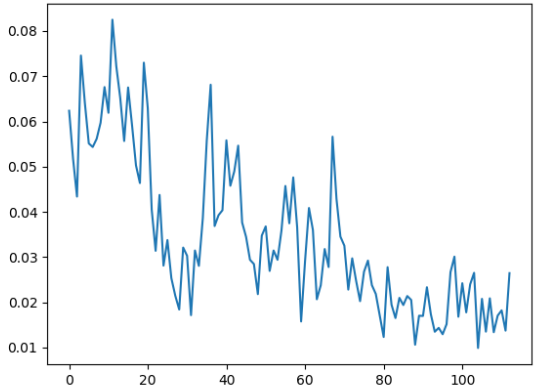
Supervised

- Random Forest
- LASSO with L1 and L2 norm

Results

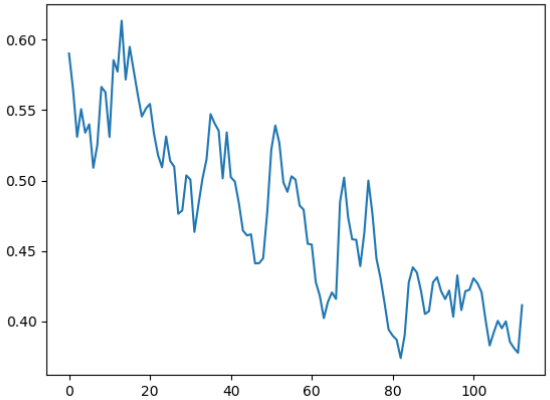


Recall Rate for Inner Product method

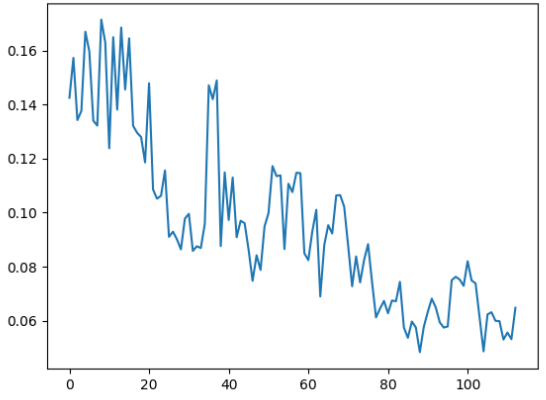


Error Rate for Inner Product method

Results



Recall Rate for PCA-64 method



Error Rate for PCA-64 method

Results

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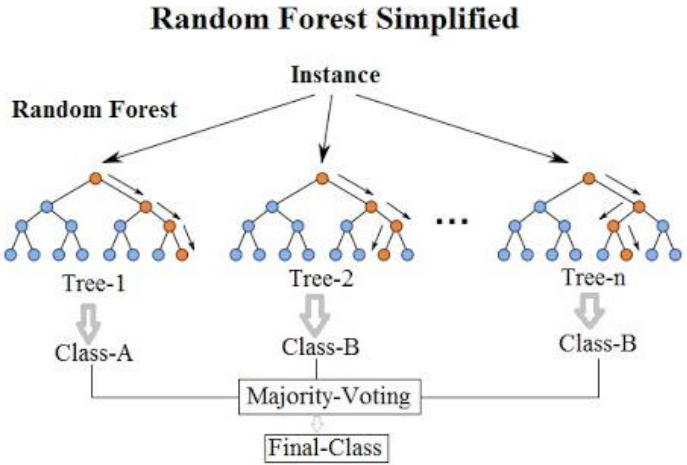
	Recall	Error Rate
Inner Product	90%	5%
VAR-80	50%	7%
VAR-64	40%	10%
VAR-32	22%	12%
VAR-16	5%	3%

	Recall	Error Rate
Inner Product	90%	5%
PCA-80	25%	5%
PCA-64	50%	10%
PCA-32	25%	10%
PCA-16	8%	5%

Random Forest

$$prediction = bias + feature_1 contribution + \ldots + feature_n contribution.$$



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Thank You!

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