PRUNING SIFT & SURF FOR EFFICIENT CLUSTERING OF NEAR-DUPLICATE IMAGES

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MOTIVATION

- Exponential increase in online image uploads.
- Clustering and categorization of these images using SIFT & SURF is time-consuming.

PROBLEM

1. Non-uniform distribution of SIFT and SURF keypoints.
2. Larger dimension of SIFT & SURF feature descriptors.
3. Traditional bag-of-features (BoF) approach for dictionary generation consumes significant computational time.

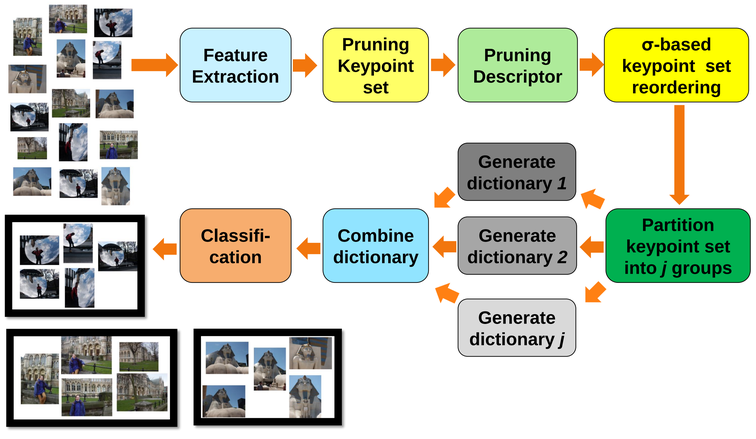
Computational complexity: $O(\boldsymbol{ndki})$

where $\boldsymbol{n}$ denotes the number of $\boldsymbol{d}$-dimensional keypoints, $\boldsymbol{k}$ is the number of visual words, and $\boldsymbol{i}$ represents the number of iterations required until convergence

SOLUTION

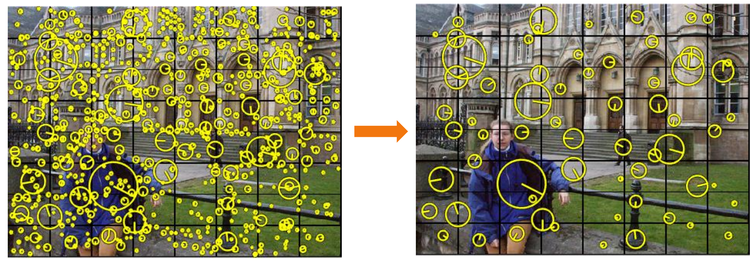
1. Selection of important and uniformly distributed keypoints.
2. Reducing the dimension of the descriptor such that the distinctiveness of SIFT and SURF is preserved.
3. Keypoint set is partitioned into multiple groups based on the strength of the features for dictionary generation.

OVERVIEW



PRUNING KEYPOINT SET

Keypoints with maximum strength in the region are retained.

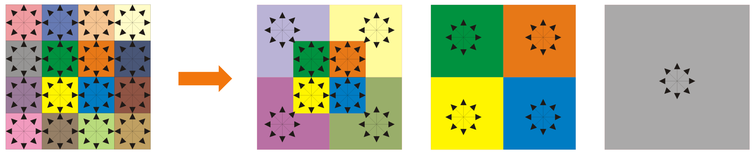


Total **895** keypoints

Pruned **64** keypoints

PRUNING DESCRIPTOR DIMENSION

The 4×4 sub-regions in the descriptor are combined such that, orientation histogram bins in the same directions are accumulated.



128*D* SIFT **64*D*** SIFT **32*D*** SIFT **8*D*** SIFT

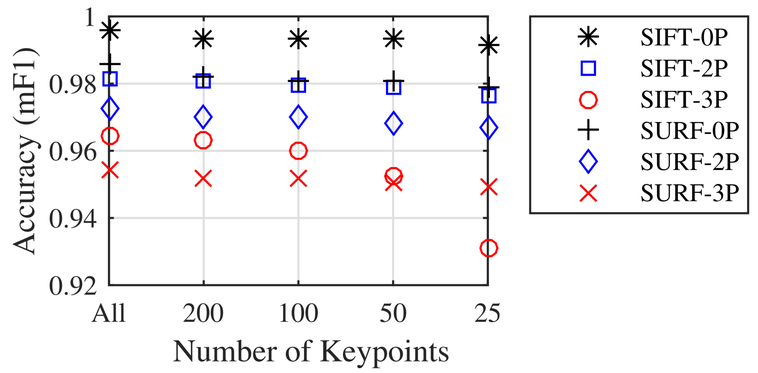
PARTITIONED BoF DICTIONARY

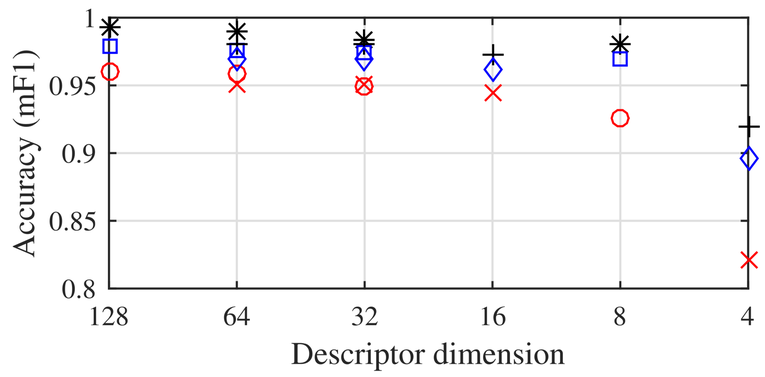
- Pruned keypoint set is partitioned into predefined subsets based on the strength (σ values) of the keypoints.
- Form separate dictionaries for each subset and combine those to obtain the overall dictionary.

CONCLUSION

- Pruning keypoint set to only 1% of the original keypoint set provides less than 0.5% decrease in the performance.
- Reducing descriptor dimension to only 6.25% of traditional SIFT provides less than 1.5% decrease in the performance.
- Hence, the proposed pruning does not significantly affect the discriminating capability of SIFT & SURF features.

RESULTS





			No Partitions (0P)		2 Partitions (2P)		3 Partitions (3P)	
	Dimension	Keypoints	Accuracy	Speed-up	Accuracy	Speed-up	Accuracy	Speed-up
SIFT	128D	All	0.9956	1	0.9814	4.1	0.9644	12.7
	128D	200	0.9933	69	0.9811	388	0.9629	802
	128D	100	0.9933	279	0.9793	1238	0.9600	2963
	128D	50	0.9933	1197	0.9789	4522	0.9522	12866
	128D	25	0.9915	3908	0.9763	3908	0.9311	39477
	64D	100	0.9900	453	0.9758	2117	0.9589	6065
	32D	100	0.9833	572	0.9742	3634	0.9489	7962
	8D	100	0.9800	1063	0.9689	5003	0.9256	12771
	8D	50	0.9789	3337	0.9456	17052	0.8867	39633
	8D	25	0.9767	11526	0.9386	52817	0.8600	121868
SURF	64D	All	0.9861	2.3	0.9728	8.9	0.9546	27.4
	64D	200	0.9823	132	0.9701	388	0.9521	1723
	64D	100	0.9811	567	0.9698	1238	0.9515	6095
	64D	50	0.9807	2402	0.9683	4522	0.9507	27602
	64D	25	0.9789	8132	0.9672	3908	0.9492	87497
	32D	100	0.9800	953	0.9690	2117	0.9510	13052
	16D	100	0.9733	1123	0.9611	3634	0.9438	19042
	4D	100	0.9200	2274	0.8964	5003	0.8216	28438