Robust statistics and no-reference image quality assessment in Curvelet domain.

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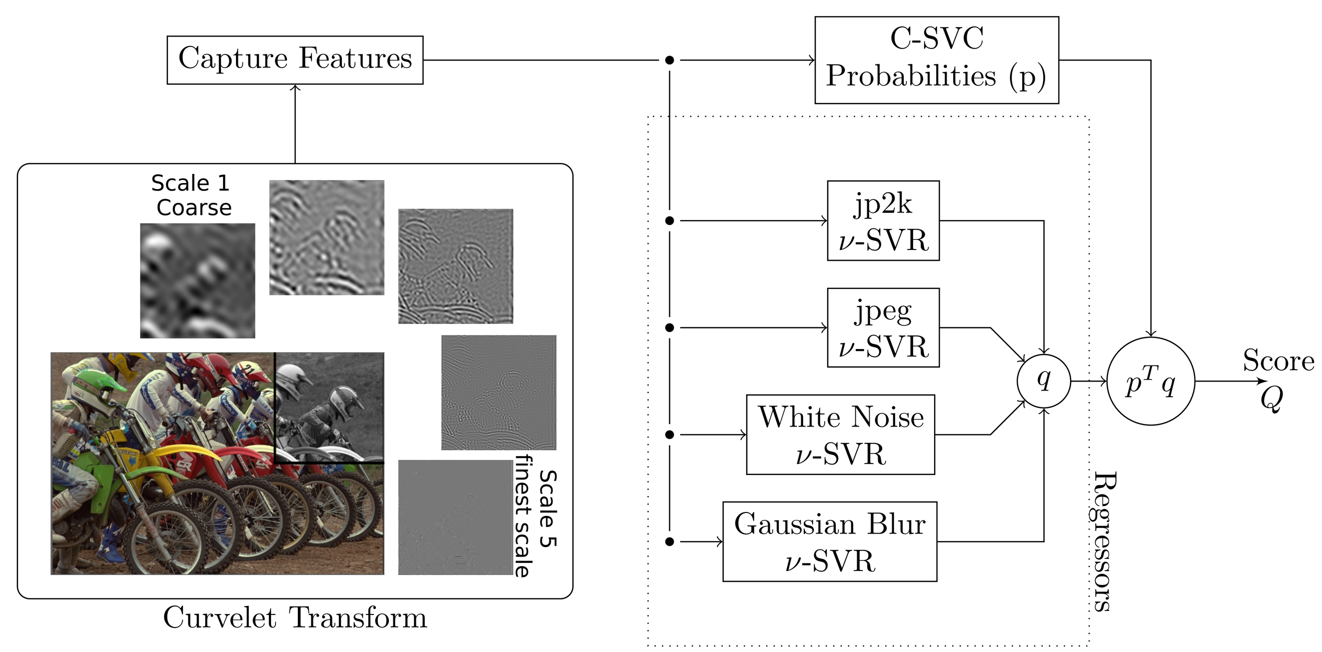
1. Introduction

This work uses robust statistics and curvelet transform to learn a general-purpose no-reference (NR) image quality assessment (IQA) model. The new approach, here called M1, competes with the Curvelet Quality Assessment proposed in 2014 (Curvelet2014)[1]. The central idea is to use descriptors based on robust statistics to extract features and predict the human opinion about degraded images. To show the consistency of the method the model is tested with 3 different datasets, LIVE IQA, TID2013 and CSIQ. To test evaluation, it is used the Wilcoxon test to verify the statistical significance of results and promote an accurate comparison between new model M1 and Curvelet2014. The results show a gain when robust statistics are used as descriptor.

2. Two-stages SVM framework[2] in Curvelet Domain



3. Structure Curvelet Coefficients

Name of layer	Scale index	Orientation number
1th Coarse	S_1	1
2th Coarse (Detail)	S_2	32
Detail	S_3	64
Detail	S_4	64
fine scale	S_5	1

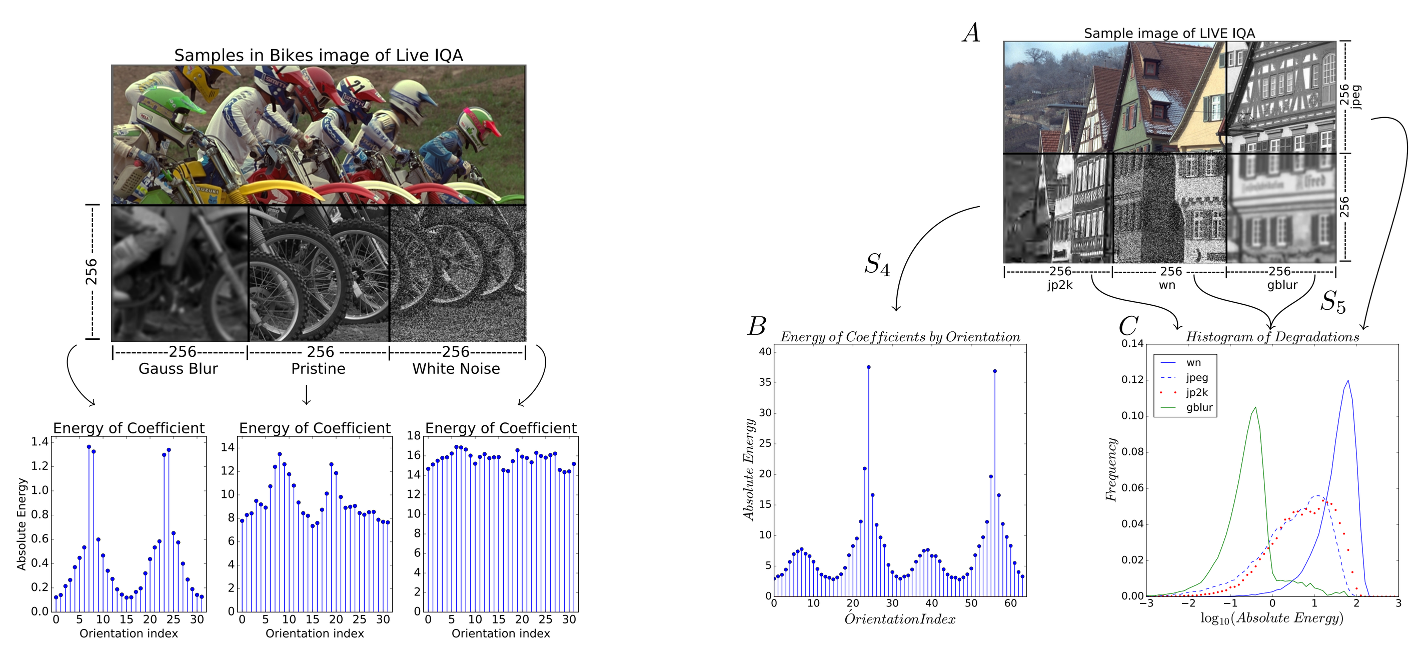
3. Features

The proposed model M1, uses 11 features: 3 features using mean energy between 4 coarse scales, 3 robust features in S_4 scale (the finest layer with multiple directions) and 5 robust features in finest layer S_5.
Spotlight for

$$\gamma = \frac{Oc_6 + Oc_2 - 2Oc_4}{Oc_6 - Oc_2} \; and \; \kappa = \frac{(Oc_7 - Oc_5) + (Oc_3 - Oc_1)}{Oc_6 - Oc_2} \; ,$$

γ is the Skewness of Bowley[3], and κ is the kurtosis of Moors[4]. The Oc_j are octiles division of S_5 coefficients.

4. Outliers and Bad Behavior



5. Datasets

It was employed 4 types of degradetion: compressions jpeg (jpeg) and jpeg2000 (jp2k), additive white Gaussian noise (wn) e Gaussian blur (gblur).

Live IQA : 29 reference images and 634 degradation images.

TID2013 : 24 reference images and 480 degradation images.

CSIQ : 30 reference images and 600 degradation images.

5. M1 vs. Curvelet2014

	SROCC	KROCC	Accuracy
	LIVE IQA 20%		
M1	0.8795	**0.7392**	**0.8627**
Curvelet2014[1]	0.8762	0.7198	0.8248
	TID2013		
M1	0.8392	0.6541	**0.8148**
Curvelet2014[1]	0.8401	0.6525	0.7791
	CSIQ		
M1	**0.7764**	**0.5834**	**0.7235**
Curvelet2014[1]	0.7470	0.5470	0.6905

Mean values of correlation (and accuracy) in 200 realizations, models trained with 80% do LIVE IQA with random selection. We use white lines for M1 and gray lines for Curvelet2014. The bold values indicate better result and rejection the null hypothesis. Persistent bold values in column or line indicate better model.

		jp2k	jpeg	wn	gblu
	LIVE IQA 20%				
SROCC	M1	**0.8743**	0.8805	1	0.9045
	Curvelt2014[1]	0.8373	**0.9309**	0.9990	0.9175
KROCC	M1	**0.7867**	0.8116	1	0.8850
	Curvelet2014[1]	0.7337	**0.8676**	0.9980	0.8830
	TID2013				
SROCC	M1	**0.8447**	**0.8365**	**0.9058**	0,8548
	Curvelt2014[1]	0.7703	0.8337	0.8784	**0.8608**
KROCC	M1	**0.6467**	0.6337	**0.7284**	0.6592
	Curvelet2014[1]	0.5742	0.6353	0.6967	**0.6658**
	CSIQ				
SROCC	M1	**0.7964**	0.7747	**0.8875**	**0.7836**
	Curvelt2014[1]	0.7252	**0.7861**	0.8674	0.7105
KROCC	M1	**0.5868**	0.5670	**0.6989**	**0.6070**
	Curvelet2014[1]	0.5230	**0.5750**	0.6773	0.5255

6. Conclusions

The model M1 has better global performance,don't lose any test. A spotlight for classification and CSIQ test.
For the experiments by type of degradation, M1 has superior performance in jpeg2000 and white noise degradation. The degradation jpeg is not favored in M1. The degradation Gauss blur do not have favor model, but M1 has small variation.

7. References

[1] Dong Liu Lixiong, Huang Hua Hongping, and Bovik Alan C. No-reference image quality assessment in curvelet domain. *Signal Processing: Image Communication*, 29(4), 2014.

[2] A K Moorthy and A C Bovik. A Two-Step Framework for Constructing Blind Image Quality Indices. *IEEE Signal Processing Letters*, 17(5):513–516, 2010.

[3] Richard A. Groeneveld and Glen Meeden. Measuring skewness and kurtosis. *Journal of the Royal Statistical Society. Series D (The Statistician)*, 33(4):391–399, 1984.

[4] J. J. A. Moors. A quantile alternative for kurtosis. *Journal of the Royal Statistical Society. Series D (The Statistician)*, 37(1):25–32, 1988.