Unnaturalness Modeling of Image Distortions

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Natural scene statistic (NSS) models are effective tools for formulating models of early visual processing. One area where NSS models have been successful is predicting human responses to image distortions, or *image quality assessment* (IQA) by quantifying *unnaturalness* introduced by distortions.

Recent *Blind* IQA models use NSS features to form predictions of human judgments of distorted image quality without having available corresponding undistorted reference images. Successful *learning blind* models have previously been developed that learn to accurately predict human opinions of image quality by training them on databases of distorted images and associated human opinion scores.

We introduce new NSS feature based blind IQA models that require even less information to attain good results. If human opinion scores of distorted images are not available, but a database of distorted images is, then *opinion-less blind* IQA models can be created that perform well.

We have also found it possible to design blind IQA models without *any* source of prior information other than a database of distortionless "exemplar" images. An algorithm derived from such a *completely blind* model has only the distorted image to be quality-assessed available.

Our new blind IQA models (Fig. 1) follow four processing steps (Fig. 2). Images are decomposed by an energy compacting filter bank then divisive normalized, yielding responses well-modeled as NSS. Either NSS features alone, or both NSS and distorted image statistic (DSS) features are used to create distributions of *visual words.* Quality prediction is expressed in terms of the Kullback-Leibler divergence between the distributions of visual words from distorted images and from the space of exemplar images. Both opinion blind and completely blind models compete well with standard non-blind metrics such as mean squared error (MSE) when tested on a large public IQA database (Tables 1 and 2).

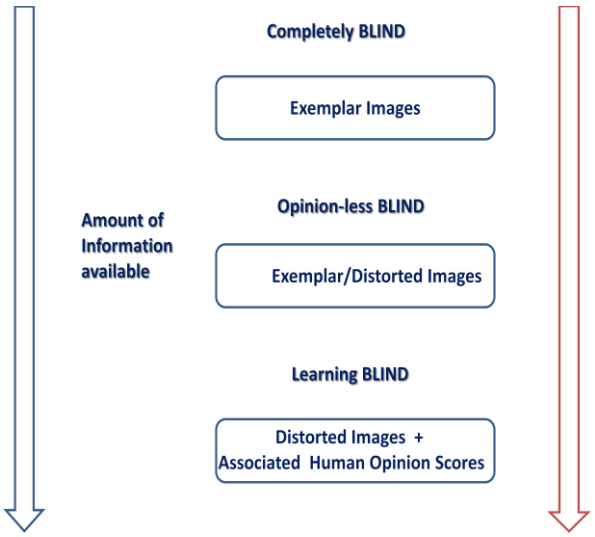

Figure 1: Blind image quality assessment models requiring different amounts of prior information.

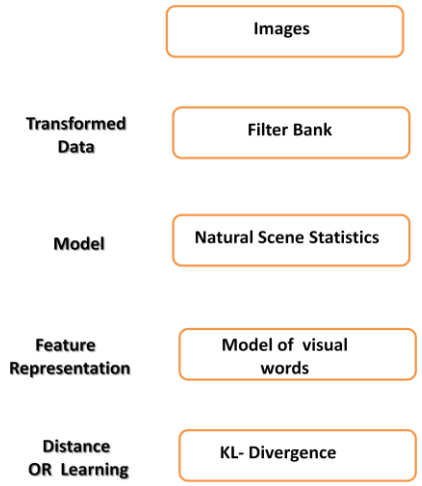

Figure 2: Block diagram of generic NSS based IQA framework.

	JPEG 2000	JPEG	White Noise	Gaussian Blur	Fast fading	Overall
Completely BLIND	0.7837	0.8729	0.9481	0.8070	0.8074	0.7945
Opinion BLIND	0.9119	0.8672	0.9538	0.9219	0.8193	0.8828
MSE	0.8995	0.8899	0.9861	0.7837	0.8897	0.8723
Learning BLIND	0.9090	0.9551	0.9903	0.9498	0.9148	0.9377

Table 1: Pearson linear correlation coefficient of completely blind and opinion blind objective quality assessment approaches with average human opinion scores on LIVE image quality assessment database. To create models of visual words, a set of 500 exemplar images were taken from the web. 5 kinds of distortions – JPEG 2000, JPEG, White Noise, Gaussian Blur, and Fast fading channel noise were introduced in each image to a varying degree of severity resulting in a total of 500 distorted images for each distortion category

	JPEG 2000	JPEG	White Noise	Gaussian Blur	Fast fading	Overall
Completely BLIND	0.7797	0.8483	0.9400	0.7941	0.7969	0.8111
Opinion BLIND	0.9041	0.9145	0.9483	0.9128	0.8170	0.8895
MSE	0.8951	0.8812	0.9853	0.7812	0.8904	0.8754
Learning BLIND	0.8999	0.9467	0.9849	0.9435	0.8861	0.9314

Table 2: Spearman rank ordered correlation coefficient of completely blind and opinion blind objective quality assessment approaches with average human opinion scores on LIVE image quality assessment database.