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Low bit Rate Video Quality Analysis Using NRDPF-VQA Algorithm

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ABSTRACT

In this work, we propose NRDPF-VQA (No Reference Distortion Patch Features Video Quality Assessment) model aims to use to measure the video quality assessment for H.264/AVC (Advanced Video Coding). The proposed method takes advantage of the contrast changes in the video quality by luminance changes. The proposed quality metric was tested by using LIVE video database. The experimental results show that the new index performance compared with the other NR-VQA models that require training on LIVE video databases, CSIQ video database, and VQEG HDTV video database. The values are compared with human score index analysis of DMOS.

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1. INTRODUCTION

We know the underlying `quality aware' natural video statistics model in the space-time domain and describe perceptually relevant temporal features that are used to model inter subband correlations over both local and global time spans [2, 4, 6, 14, 19, 22]. The overall model is the basis on an algorithm for predicting video quality that is shown to correlate well with human judgments of visual quality. We also compare it's performance to state-of-the-art FR and NR VQA approaches [18]. Before we describe the model in detail, we review relevant prior work in the area of VQA. We create a `zero shot' NR VQA model by making measurements of perceptually relevant temporal video statistics [14]. Natural videos contain regular structures and have generally piece-wise smooth luminances in spacetime separated by sparse spatio-temporal edge discontinuities [16]. This strong property of natural videos has been exploited in a variety of applications. It induces self similarity over space and time which, for example, has been exploited for resolution enhacement, action recognition, RR and NR VQA [12, 19, 21]. Self similarity statistics computed using differences between consecutive frames have been used to capture distortion-induced anamolous behavior and to conduct visual quality inference. Deriving inspiration from these examples, we model temporal self similarities using frame differences between consecutive frames. Once the normalized coefficients for each subband are computed, each coefficient map is partitioned into P X P patches [14, 19]. Features are extracted using the coefficients of each patch. The coefficients of each sub-band are modeled as obeying a generalized Gaussian distribution, which effectively captures the behavior of the coefficients of natural and distorted of videos [17].

We have proposed the use of exemplar natural picture content as ground truth relative to which statistical regularity may be determined. Such a model, however, may be limited in that it can only capture common baseline characteristics of a specific collection of non-distorted content, and is thereby not able to universally represent video specific intrinsic characteristics [1, 9, 12]. Also, the construction of such a database requires the unbiased selection and maintainence of hundreds of natural undistorted videos. This also raises the question of how many exemplar videos are needed to design an accurate natural video model, and how distinctive these need to be relative to each other and to the world of videos [4, 9, 12, 17]. Finally, given the limitations of image/video camera capture, distortions are inevitably introduced in the capture process and hence the procurement of perfectly natural `pristine' videos is practically impossible [16].

2. RESEARCH METHOD

The approach for the NRDPF- VQA (No Reference Distortion Patch Feature Video Quality Analysis) that we have developed can be summarized as follows. Given a (possibly distorted) video having low bit rate, first compute encoding and decoding of the frames selected by the video duration. The following are the equations to to applied to a given distortion video [15].
The equations represent the features of the distortion patches of video. It also observed that the normalized luminance values strongly tend towards a unit normal Gaussian characteristic for video. Compute the MATLAB program for the equations.

$$S = \begin{bmatrix} f(M_x) & f(M_x.M_y) \\ f(M_x.M_y) & f(M_x) \end{bmatrix}$$

Where $f(V) = \sum_{l,k} w[i,j]V(i-1,j-k)^2$
$M_x(i,j)$ and $M_y(i,j)$ are horizontal and vertical motion vectors at pixel (i,j) respectively, w is the window of dimension m X m over which the localized computation of the tensor is performed.

$$C = \left(\frac{\lambda_1 - \lambda_2}{\lambda_1 + \lambda_2}\right)^2$$

$$f(x|\alpha,\beta,\gamma) = \alpha e^{-(\beta|x-\mu|)^\gamma}$$

$$\alpha = \frac{\beta\gamma}{2\Gamma(1/\gamma)}$$

$$\boldsymbol{\beta} = \frac{\mathbf{1}}{\boldsymbol{\alpha}}\sqrt{\frac{\boldsymbol{\Gamma(3/\gamma)}}{\boldsymbol{\Gamma(1/\gamma)}}}$$

$$\Gamma(z) = \int_0^\infty t^{z-1}\ e^{-t}dt \quad z>0$$

The NRDPF-VQA algorithm is designed for this video quality assessment purpose. The MATLAB code is developed for entire equations.

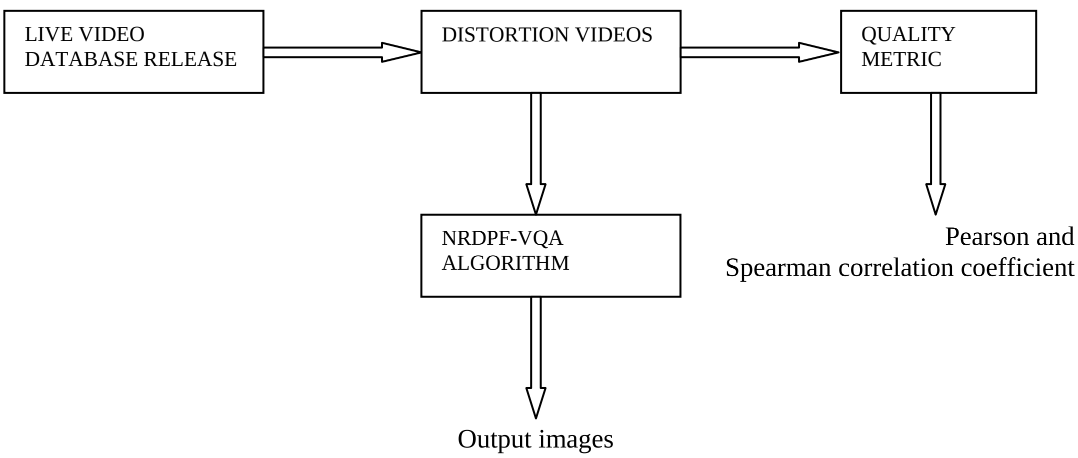

Figure 1. Experimental setup using LIVE database

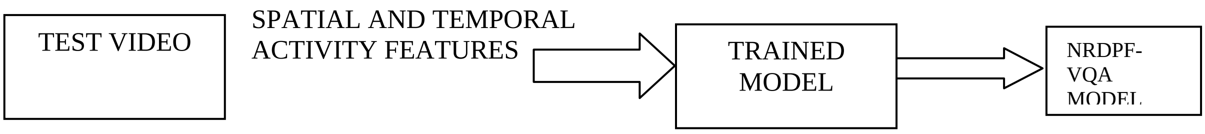

Figure 2. NRDPF-VQA model frame work

3. RESULTS AND ANALYSIS

While we are using a probabilistic framework for distortion classification where we use the probability of video being distorted with a particular distortion, but just as a proof of how good the featues used in the framework act as distortion identifiers and also which distortions are misclassified with which ones, we are reporting the confusion matrix for first stage classification. We would like to point out that each entry in the confusion matrix is the mean of confusions across LIVE video database. We can see from database that H.264/AVC format is confused with other formats. Also, MPEG-2 and IP are also confused sometimes. White noise and Blur are comparatively more robust in detection and not confused usually with other distortions.

(a)

(b)

(c)

(d)

(e)

(f)

(g)

Figure 3. Images from (a) to (g) are consider for H.264 Video with low bit rate

As we computed have correlations for each algorithm over train test trials, we find mean SROCC value and the standard error associated with these correlation values. We plot the same across the dataset along with error bars one standard deviation wide for each of the evaluated algorithms.

Table I. Ground truth and NRDPF-VQA for videos (a), (c), (d), (f) and (g) from live VQA database

Video	a	c	d	f	g
Actual	0.9500	1.4600	1.1800	1.1800	0.5000
VL bit-rate	1.0923	1.2651	1.1981	1.0189	0.9365
NRDPF-VQA (Proposed)	1.0021	1.3642	1.1842	1.1792	0.6245

Table II. Median SROCC correlations on every possible combination of train/test set splits (subjective DMOS Vs NRDPF-VQA DMOS). 80% of content used for training

Distortion	PSNR	SSIM	VQM	STMAD	MOVIE	RRED	VIDEO-BLIINDS	NRDPF-VQA
MPEG-2	0.667	0.786	0.828	0.9484	0.9286	0.809	0.882	**0.9514**
H.264	0.714	0.762	0.828	0.9286	0.9048	0.885	0.851	**0.9312**
Wireless	0.680	0.714	0.714	0.7976	0.800	0.771	0.802	**0.8124**
IP	0.660	0.600	0.770	0.7143	0.788	0.771	0.826	**0.8436**
ALL	0.671	0.650	0.7451	0.8250	0.807	0.826	0.821	**0.8514**

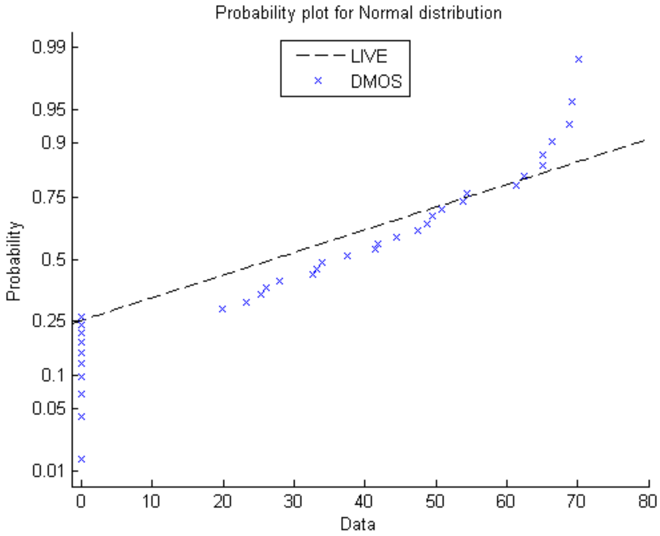

Figure 4. Probability Plot for DMOS index for H.264 format

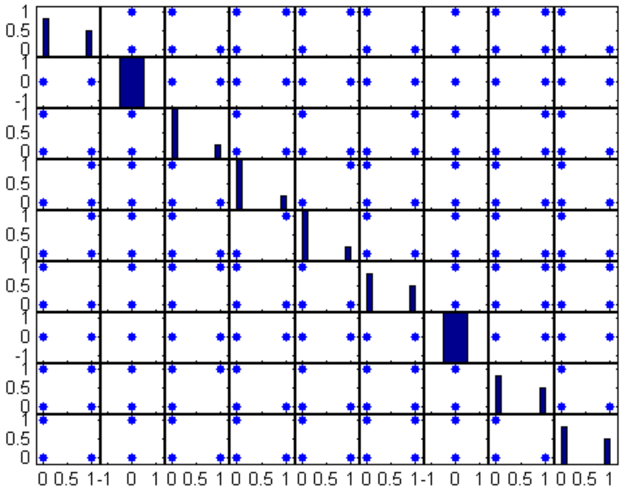

Figure 5. Plot for Frame features for H.264

4. CONCLUSION

We proposed a No reference Video based quality assessment model NRDPF-VQA which performs quality assessment of Video with out any information from distortion image. No distortion specific features such as noise; blur has been modeled in the algorithm in specific. The algorithm only quantifies the blind in the video due to presence of distortions. The designed framework is spatial domain, human perception based, simpler and faster which makes it superior to other no reference algorithms. The index is been shown to perform well across different distortions verifying its distortion agnostic nature. An exhaustive analysis of performance is done using LIVE VQA database, CSIQ Video database and VQEG HDTV Video database on four kinds of distortions through spearman rank ordered correlation coefficent. The frame work is found to perform statistically better than other proposed no reference algorithms.

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