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Perceptual-Based Quality Metrics for Image and Video Services

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Abstract – A single, focused image can be composited by selecting the best-focused match in the stack for each image region (Clarke, 1985. Mallat, 1999). The optimal choice of parameters, including focus and aperture, for the images in a focal stack are well established (Ding, et. al., 2007). Capturing a focal stack with a large-scale high-resolution camera was implemented. Multiplex a focal stack into a single sensor image in a similar fashion as colour arrays multiplex different color channels into a RAW camera image. However, to the knowledge of the author, this camera has not yet been built. Split the aperture of a camera using circular mirrors and multiplex the result into different regions of a single photograph.

Keywords - Image. Quality, Optimal

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1. INTRODUCTION

Other types of images can also be treated as layered images via the use of bit plane separation. This assigns one bit from the binary representation of the pixel value into 20 each bi-level layer, thus lossless separating any gray scale image into eight layers. In the case where there is a correlation between the bit layers, it is possible to utilize this to gain better compression efficiency. For example, in context modeling, involving neighboring pixels from already processed binary images can improve the probability estimation and, therefore, the compression. Among existing implementations we can mention the EIDAC (Mallat, 1999) lossless compression algorithm, which uses a binary multi-layer context model that operates on bit-layers of the image using both the actual bit values and their differential characteristics as context information. Two-layer context modeling with optimization of the order of layer processing was considered in(Balasubramanian, Allebach, 1995).

In P2, we study how well the bit-plane-based approach can work on natural and palette images. We consider four different bit plane separation schemes: straightforward bit plane separation, Gray-coded bit plane separation, bit plane separation of prediction errors and separation of Gray coded prediction errors. We use the highly optimized MCT context modeling method for lossless compression and, furthermore, extend the two-layer MCT model to a multi-layer context model for better utilization of cross-layer dependencies. In general, any previously compressed layer can be used to provide the contextual information for the next layer being compressed. An example of a multi-layer neighborhood used in P2 is presented in Figure 6. We extensively evaluate the proposed combinations of the different bit plane separation and context modeling schemes, by applying them to natural and palette images. The efficiency of the bit-plane-based compression is compared to the existing compressors. Moreover, the dependency of the compression on the image content is studied by modeling the transition between natural and palette image classes.

Here, the integral parts of a wireless link are shown including source encoder, channel encoder, modulator, and the wireless channel. In this scenario, the received image or video may from artifacts, and consequently quality degradations, from both the source encoder and the error-prone wire-less channel. The impact of the source coding artifacts is somewhat easier to predict since for different codes certain artifacts can be expected. On the other hand, the time variant nature of the fading channel makes the range of artifacts in the received signal much more unpredictable. With JPEG source encoding and a Rayleigh °at fading wireless channel with additive white Gaussian noise (AWGN). The symbiosis of this setup resulted in a wide range of different artifacts, hence, substantially complicating the assessment of the artifacts and the related visual quality. The additional shaded boxes in comprise of the necessary components to facilitate perceptual quality assessment, as we propose it in this study. The blocks surrounded by dashed lines indicate optional parts of the quality assessment, which are applied when reference features are extracted from the transmitted image to support the quality assessment, hence, facilitating RR quality assessment. On the other hand, if these blocks are omitted then quality assessment is performed solely on the received image, thus, following the NR approach. However, as we aim to quantify quality degradations induced during transmission, we need some reference information from the transmitted image or video frame. Therefore, we incorporate the reference feature extraction into our metric design to establish RR objective quality metrics. In this case, the reference features may be concatenated to the transmitted image or video frame to be available at the receiver for quality assessment. The number of bits associated with the reference features the overhead for each of the images it is concatenated with and accordingly it is desired to be kept small.

2. REVIEW OF LITERATURE

This latter goal is followed by incorporating several characteristics of the HVS into the metric design to allow for superior quality prediction performance as compared to metrics that purely measure similarity between images (Clarke, 1985). In order to further support the design of the objective metrics we have conducted subjective image quality experiments at the Western Australian Telecommunications Research Institute (WATRI) in Perth, Australia, and at the Blekinge Institute of Technology (BTH) in Ronneby, Sweden. The mean opinion scores (MOS) obtained from these experiments allowed us to relate the different measures incorporated in the objective metrics to subjectively perceived visual quality. The MOS further enabled evaluation of the quality prediction performance of the metrics on both a set of training images that were used for the metric design and a set of validation images that were unknown during metric training. Unlike previously proposed HVS based quality metrics (Gonzalez, Woods, 2002. Pitas, 2000. Dougherty, Astola, 1997) that incorporate a large number of HVS properties, we focus on a few simple approximations of HVS characteristics that have been shown to be essential for the visual perception of quality. Specifically, the basis for the metric designs is motivated by the phenomenon that the HVS is adapted to extraction of structural information (Gersho, Gray, 1992. Pitas, Venetsanopoulos, 1990). Thus, a number of structural features are extracted that accurately quantify the artifacts observed in wireless image and video communication. An additional weighting then controls the impact of each feature on the overall metric. The weights are derived in relation to the MOS from the experiments and thus account for the perceptual relevance of each of the artifacts. Additional HVS characteristics, such as, multiple-scale processing and regional attention will be shown to further enhance the metrics quality prediction performance. The latter characteristic has been supported by an additional subjective experiment that we conducted at BTH to identify regions-of-interest in the set of reference images and thus allow for implementation of region-selectivity in the metric design. To account for non-linear quality processing in the HVS, all metrics are in a last step subject to an exponential mapping. The mapping translates the metric values into so-called predicted MOS which aim to measure the quality as it would be rated by a human observer.

3. PERCEPTUAL-BASED QUALITY METRICS FOR IMAGE AND VIDEO SERVICES

This part consists of a survey of contemporary image and video quality metrics. The work is a result of an intensive literature research, which has been carried out to investigate previously, conducted image and video quality research and also to identify open issues that need to be addressed. Only few reviews and surveys about image and video quality metrics have been published in the past [Ageenko, Fränti, 2000. Plataniotis, *et. al.,* 1997). In contrary to these related works, this survey concentrates on metrics that aim to predict quality as perceived by a human observer and further belong to the class of NR and RR metrics. The latter property enables quality prediction of a distorted image/video without a corresponding reference image/video to be available. Hence, these metrics are readily applicable in wireless and wire line image and video communication, where the original image or video is unavailable for quality assessment at the receiver. The survey provides a detailed classification of the available quality assessment methods. It further discusses the advantages and drawbacks of a broad range of available NR and RR metrics that have been proposed in the past. Two extensive tables provide direct overviews with the aim for the reader to easily identify the appropriate metric for a given task. The tables provide information about the artifacts (blocking, blur, etc.), the domain (spatial, frequency, etc.), the source codecs (JPEG, MPEG, etc.), and the typical image/frame size, which the metrics have been designed for. Finally, some open issues in image and video quality assessment are outlined in the conclusions.

4. REDUCED-REFERENCE METRIC DESIGN FOR OBJECTIVE PERCEPTUAL QUALITY ASSESSMENT IN WIRELESS IMAGING

The metric is based on the work conducted earlier in (Kenney, *et. al.,* 2001. Ageenko, Fränti, 2000. Plataniotis, *et. al.,* 1997).

Extreme value feature normalization:

The structural feature algorithms included in the objective metric are implemented according to algorithms as outlined in different publications (Gonzalez, Woods, 2002. Pitas, 2000. Dougherty, Astola, 1997. Pitas, Venetsanopoulos, 1990. Kuwahara, *et. al.,* 1976). Consequently, the ranges of the different features were strongly varying. In this work, we therefore introduce extreme value normalization in order for the features to fall into a defined interval.

Perceptual relevance weighted LP-norm for feature pooling:

An alternative feature pooling based on a perceptual relevance weighted LP-norm is proposed. The resulting metric provides similar quality prediction performance as NHIQM while at the same time allowing tracking the structural degradations independently for each of the features. Thus, insight into the artifacts induced during transmission may be gained using this feature pooling.

Statistical analysis of subjective experiments and objective features:

An in-depth statistical analysis is provided for the subjective experiments that we conducted in two independent laboratories. The analysis reveals the relevance of the subjective scores obtained in the experiments. In addition, a detailed analysis of the objective feature scores from the experiment test images is discussed revealing insight into the artifacts that were objectively quantized by the feature metrics.

Metric training and validation:

The concept of metric training and validation has further been introduced to the work to verify that the metric design does not result in over writing to the training data but rather allows for good generalization to unknown images.

Motivation for a non-linear mapping functions:

Using the training and validation approach we further motivate the use of an exponential prediction function to account for the non-linear processing in the HVS. Other prediction functions can be excluded due to inferior goodness of measures, visual inspection, and over fitting on the training set of images.

Comparison to state of the art visual quality metrics:

State of the art visual quality metrics (Gersho, Gray, 1992. Ding, *et. al.,* 2007. Gonzalez, Woods, 2002) are considered in this work for comparison of quality prediction accuracy, prediction monotonicity, and prediction consistency (Mallat, 1999) on both the training and the validation set of images. The evaluation reveals the superior quality prediction performance of NHIQM with respect to all three criteria.

CONCLUSION

As a result of solid-state multispectral scanners and other raster input devices, we now have available digital raster images of spectral reflectance data. The chief advantage of having these data in digital form is that they allow us to apply computer analysis techniques to the image data a field of study called Digital Image Processing. Digital Image Processing is largely concerned with four basic operations: image restoration, image enhancement, image classification, image transformation. Image restoration is concerned with the correction and calibration of images in order to achieve as faithful a representation of the earth surface as possible a fundamental consideration for all applications. Image enhancement is predominantly concerned with the modification of images to optimize their appearance to the visual system.

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