ROI-PRESERVING MULTIPLE DESCRIPTION CODING BASED ON PRE- AND POST-PROCESSING TO STANDARD ENCODERS

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ABSTRACT

Multiple description coding of images can be implemented as pre- and post-processing by means of simple splitting of the pixels into subimages. A controllable amount of extra redundancy is inserted in order to improve estimation quality in case of one descriptor reception. This redundancy is usually inserted in a uniform spatial fashion. In this papers we propose a novel pre- and post-processing method which exploits the directional spatial characteristics of a region of interest in order to protect it in a multiple description coding scenario. Simulation results show a noticeable performance with respect to other proposed methods.

1. INTRODUCTION

Multiple description coding (MDC) [1] is recognized as an effective method to protect multimedia information transmitted over networks subject to erasures. In the MDC approach, two or more correlated descriptions of the same data are generated, which can be independently decoded, and yield mutually refinable information. Therefore, the quality of the recovered signal is dependent only on the number of received descriptions, and not on the specific loss pattern. Many methods have been proposed for the generation of MD, among which MD scalar quantization [2], correlating transforms [3] and so on. With some modifications these methods can be used to insert redundancy in spatial localized fashion so that a given region of interest (ROI) is more protected against packet losses. However, these methods are not compatible with standard image/video co-decoding tools; therefore their use is not suitable for many multimedia applications. On the other hand, techniques which enable the creation of MD of images by means of pre- and post-processing to standard co-decoders [4], such as JPEG or JPEG2000, are very attractive. In [5] it was suggested to use a non linear geometric transform in order to add redundancy mainly to the ROI. This method aims to increase the ratio of the number of pixels in the ROI to the total number of pixels in the image. In this paper, we propose a novel method for generating pre- and post-processing MD, while preserving a given ROI. This is done by means of over sampling of the ROI by zero padding in the transform domain.

2. ROI-DIRECTIONAL MULTIPLE DESCRIPTION SCHEME

The proposed algorithm, named in the following *ROI preserving Directional Multiple Description* (ROI-DMD) scheme, is configured as a pre- and post-processing stage, which can be combined with any image compression tool. First of all, a rectangular ROI is defined, as a subset of the original image; then, the direction along which the ROI subimage exhibits a smoother behavior is selected for the subsequent expansion, assuming that, being more correlated, it is easier to predict. A slice perpendicular to the expansion direction and containing the ROI is then defined. In the following, for the sake of simplicity, we assume that the best expansion direction is horizontal. In this case, the rows of the slice are DCT-transformed, and padded by a proper number of zeros. Then, the inverse DCT of rows is operated, resulting in a horizontal expansion of the slice. The two descriptions are generated by simple splitting of the even and odd columns of image. Finally, the descriptions are separately encoded using the preferred encoding tool; in this paper, we employ JPEG. The decoding procedure depends on whether one or two descriptions are received. In case of one description reception, the received bit stream is processed employing the selected decoder (e.g. JPEG); then, the rows are upsampled, and a simple first order linear estimator is employed to restore the missing information. At this point we deal with an image which contains an expanded slice, the expansion being equal to the amount of zero padding N_p. In order to come back to the original size, the DCT is evaluated row-wise in the expanded slice, and padded with an amount of zeros such that the obtained length is twice the ROI width. By taking the inverse DCT, and averaging adjacent columns we recover the original slice dimensions. In case of two description reception, these latter are separately decoded, and the columns of the obtained sub images are interleaved. From this point on, the same operations are performed as in the case of single description reception. As for the selection of the best direction for ROI expansion, a simple algorithm is addressed whose goal is to determine whether the ROI exhibits more high frequency components in the horizontal or vertical direction. The basic idea is that little high frequency components mean that the image is more predictable in that direction, which is therefore the best candidate for expansion. To this end, the rows of the ROI are processed using the high pass Haar 2-tap

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filter; then, the average energy of the filtered ROI over all rows is evaluated, and stored as the row parameter. The same operation is performed columnwise, and the column parameter is evaluated. The direction of expansion is then selected, based on which of these two parameters exhibits the lowest value [1].

3. SIMULATION RESULTS

The ROI-DMD algorithm has been tested employing the image Elaine of dimension $512 * 512$. A ROI of dimension $132 * 132$ pixels centered on the girl's face, is defined. The slice has been expanded horizontally - as suggested by the selection algorithm - with a zero padding factor which yields an approximately double ROI size. The performance of ROI-DMD are reported in Fig. 1-(a) and (b) for the whole image and the ROI respectively. The side and central PSNR in dB, is evaluated as a function of the bits per source symbol (bpss). For the sake of comparison, the performance of the non linear geometric transform in [5](NLGT) and of single description JPEG coding (SDC), which represents an upper bound to the central PSNR, are reported as well.

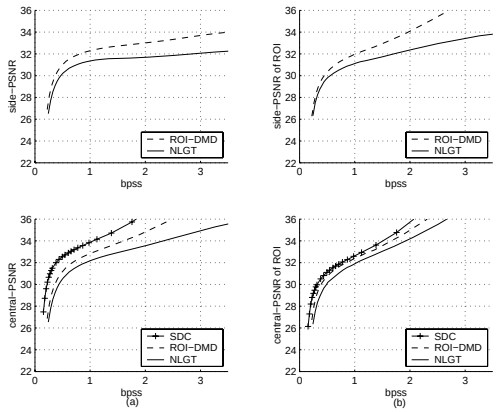

Figure 1. Central and side PSNR vs. bits per source symbol (bpss); (a): the whole image; (b): ROI subimage

It can be noticed that ROI-DMD yields better performance than NLGT, and, within the ROI, it approaches that of SDC; this improvement is mainly due to the localized and efficient insertion of the extra redundancy. In order to validate the effectiveness of the directional approach, we have also simulated the case of non suggested expansion mode on the same image. As expected, the obtained results shows an appreciable impairment with respect to the suggested expansion.

4. CONCLUSION

In this paper we have presented a novel scheme for the protection of ROI in a pre- post-processing MDC scenario. This approach enables the insertion of spatially localized redundancy in an efficient way; moreover, the amount of redundancy can be easily controlled, since the method is linear. A major advantage of the proposed algorithm is that it exploits the spatial correlation characteristics of the ROI. In the special case when the ROI coincides with the whole image, we can generate MDC of image where the extra redundancy is controlled be the quantity of zero padding. This method can be generalized to the generation of MDC for video sources; moreover, different zero padding factors can be used in the ROI and the background in order to achieve various trade-off between overall and ROI quality.

5. REFERENCES

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[1] a more sophisticated algorithm for selecting expansion direction is required in case of non circular or non square ROI