REINDEXING TECHNIQUES

Synonyms: *Color palette reordering.*

Definition: *Imaging algorithms able to reorder the color palette of color-mapped images. Such techniques are able to reduce the overall entropy of the signal attacking the local index redundancy.*

In color-mapped imaging, higher compression of color-mapped data is often achieved by reducing the local index redundancy. The so-called reindexing techniques aim at finding the optimal reordering without the consideration of all possible color indexing combinations ($M!$ combinations for an image with M colors). The existing reindexing algorithms are devoted to obtain respectively color and index similarity. An extensive survey of popular reindexing techniques can be found in [1].

The pixels in the image I with m rows, n columns, and M distinct colors can be represented as $I(x,y) = P(I'(x,y))$, where $P = \{S_1, S_2, \ldots, S_M\}$ is the set of all the colors in I, and I' is an $m \times n$ matrix of indexes in $\{1, 2, \ldots, M\}$. Most of the compression engines proceed by coding the data attacking the local spatial redundancy. For indexed images, an ordered scan of the indexes in I' named p_1, p_2, ...,$p_{m \times n}$ is usually performed. The residual entropy of local differences can be considered to estimate the overall "energy" of the signal. The information needed for the reconstruction of the original image is [1], [2]:

- the color of pixel p_1;
- a table providing the correspondence between colors $S_1, S_2, \ldots, S_M$ with indexes $i_1, i_2, \ldots, i_M$; and
- the set of differences: $D(I') = \{d_{x,y} \mid x = 1, 2, \ldots, m;\ y = 1, 2, \ldots, n\}$ where each $d_{x,y}$ is a local difference obtained by considering some specific local patterns.

Information theory states [1] that any lossless scheme used to encode the set of differences $D(I')$ requires the number of bits per pixel (bpp) being greater than or equal to the zero order entropy of the statistical distribution of $D(I')$. If indexes $i_1, i_2, \ldots, i_M$ are properly ordered to produce an almost uniform distribution of values $d_{x,y}$, then the corresponding entropy should have a large value. Conversely, a zero-peaked distribution in $D(I')$ gives a lower entropy value. Hence, finding an optimal indexing scheme is a crucial step for lossless compression of indexed images. Poor results in such sense are usually obtained when using a random luminance-based ordering (default option in almost all image formats) of the indexes. Performance of the reindexing techniques can be evaluated by measuring the lossless compression (JPEG2000, JPEG-LS, and PNG applied to different datasets of indexed images) in bits per pixel [1], [2], [3]. In general, using such advanced techniques usually allows for an improvement gain of about 30% in terms of overall compression ratio.

See: Color-mapped imaging, Color quantization, GIF format, Lossless compression, Entropy encoding.

References

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2. S. Battiato, F. Rundo, F. Stanco, "Self Organizing Motor Maps for Colour Mapped Image Re-indexing", IEEE Transactions on Image Processing", vol.16, no.12, pp. 2905-2915, December 2007.

3. A. J. Pinho, A. J. R. Neves, “On the Relation between Memon’s and the Modified Zeng’s Palette Reordering Methods”, Image Vision Computing Journal, vol. 24, no. 5, pp. 534–540, May 2006.