# Color Descriptors from Compressed Images

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## Introduction:

The success of international standardization of image compression techniques resulted in a consequent increase in the number of images and videos in various media publications, web publications, etc. There was a need for a system to classify and manage the content of those compressed images and videos. The visual descriptors describe characteristics such as color, shape, texture, motion, etc. Color is one of the most important features for describing the visual content. Color histograms are one of the popular methods for indexing images. Most approaches for color based retrieval convert the color space to the more tractable HSV for similarity matching. JPEG, MPEG and H.26x are some of the many still and moving picture standards developed. Following the successful development of MPEG-1, MPEG-2 and MPEG-4 standards, a new standard called MPEG-7 was formed to describe multimedia content. Compression standards like JPEG store images in the YCbCr color space. MPEG-7 has standardized a set of color descriptors for this purpose. (1,2,3)

## MPEG-7 Color Descriptors:

MPEG-7 provides seven color descriptors which are color space, color quantization, dominant colors, scalable color, color layout, color structure, and group of frames/group of pictures color. These color descriptors can be used to embed some information on the spatial localization of color content in the color histogram. Several studies have shown the effectiveness of these descriptors in image retrieval. (5)

- **Color Space:** The color space is used to specify the color space that a given descriptor refers to. It defines four color spaces: RGB, YCbCr, HVS and HMMD. The HMMD is used only in the color structure descriptor. This provides an interoperability between various color descriptors.(2) For experimenting with color space refer to the following url for a color space converter in MATLAB. (http://www.mathworks.com/matlabcentral/fileexchange/7744-color-space-converter). The table given below shows the color spaces supported by coding standards.(1)

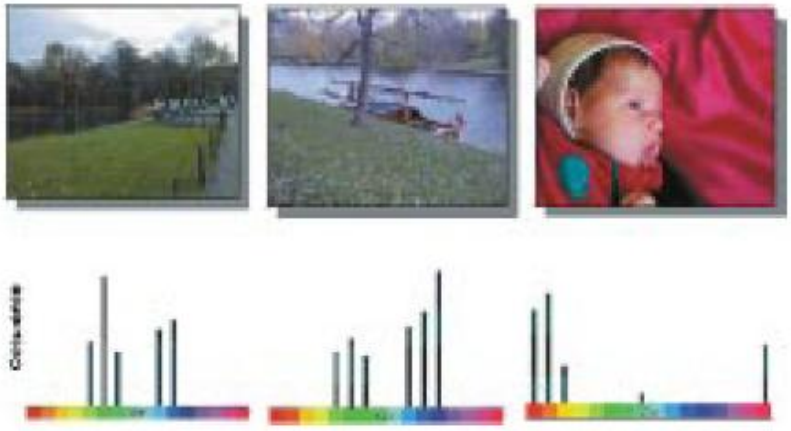
| | JPEG | JPEG2000 | MPEG-1,-2,-4 | MPEG-7 |
|---|---|---|---|---|
| **Monochrome** | YES | YES | YES | YES |
| **RGB** | YES | YES | YES | YES |
| **YCrCb** | YES | YES | YES | YES |
| **YUrVr** | | YES | | YES |
| **HSV** | | | | YES |
| **HMMD** | | | | YES |
| **Linear Matrix** | | | | YES |

- **Color Quantization :** It specifies the quantization of the given color space. It supports linear quantization of the color components, with the number of bins for each component specified independently (2)

- **Dominant color:** This descriptor gives a description of the representative colors of an image/image region. It consists of the number of dominant colors (N), and a vector of

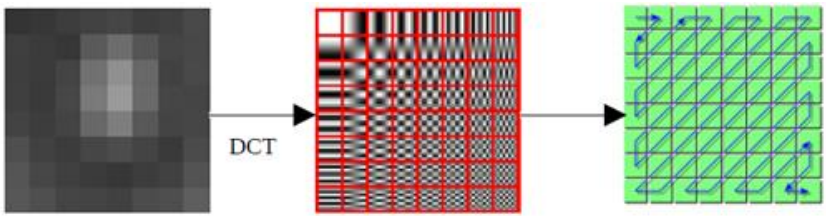
color components($c_i$) for each dominant color as well as the percentage of pixels ($p_i$) in the image/image region in the cluster corresponding to $c_i$. A more precise characterization of the color distribution can be obtained with color variance(describes the variance of color of the pixels in a cluster around the corresponding representative color) and the spatial coherence (describes the spatial distribution of pixels associated with each representative color wherein high value would indicate that pixels of similar color are co –located) . The main application of this descriptor is similarity retrieval in image databases and browsing of image databases based on single or several color values. The Dominant color descriptor has been applied in combination with the Contour Shape descriptor in a Web-based retrieval system.(2,3,5)

- **Scalable color:** This is a histogram derived descriptor and can provide the global color features when measured over an entire image. It is encoded by the Haar transform and uses the HSC color space uniformly quantized to 255 bins. The figure below shows the respective color distributions in a color histogram. Based on the color distribution the two left images would be considered as more similar compared to the one on the right. In contrast to this the DCT comes with a much more compact representation but with the expense of lower performance in certain applications. (2,3)



**Color images with MPEG-7 color histogram distribution (3)**

- **Color Layout Descriptor(CLD):** The CLD is a very compact and resolution invariant representation of color for high speed image retrieval. It captures the spatial layout of the representative colors on a grid superimposed on a region or image based on the Discrete Cosine Transform (DCT). It is expressed in the YCbCr color space. The size of the array is fixed to 8x8 elements to ensure scale invariance. It is then transformed using DCT followed by zig-zag re-oredering. This is shown in the figure given below. It can be used for fast searching of databases as well as filtering in broadcasting applications. Another application is description of video clips, where CLD is combined with the Time Series structure. (3,6)



**(image cited in :** http://www-nlpir.nist.gov/projects/tvpubs/tv9.papers/brno.pdf)

- **Color Structure Descriptor (CSD):** It is the generalization of the color histogram that captures some spatial characteristics of the color distribution in an image. It is defined in the HMMD color space using non uniform quantization, specific to Color Structure, to between 32-256 colors. A *structuring element* is defined and moved across the entire image one or more pixels at a time. At each position the color of each pixel covered by the structuring element is determined. For each color the histogram bin containing its count is incremented. The actual descriptor is obtained by normalization and non linear quantization of the final histogram. The main application envisaged for it is image/video retrieval in multimedia databases, particularly when high accuracy is required.(2)
- **Group of Frames/Group of Pictures Color:** It is an extension of the Scalable Color and defines a structure for representing color features of a collection of similar frames or video frames. It consists of average, median, and intersection histograms of groups of frames calculated based on the individual frame histograms. The intersection histogram finds the minimum common colors in the frames/pictures and can therefore be used in applications that require the detection of a high level of correlation in the color. this descriptor is useful for retrieval in image and video databases, video shot grouping, image to segment matching and similar applications. (2,3)

**The "other" descriptors:** Other than the standard color descriptors defined by MPEG-7, other descriptors like the color extensions of SIFT are also proposed. The color-SIFT methods are based on chromatic edge detection. Here the color contrast is emphasized. The improved results from this method are due to the better discrimination between the colored patches and increased invariance to shading and shadow effects. This has been tested for various levels of compression and is well described in (7,4). The following image from (7) shows the testing of color invariant descriptors with different levels of illumination, JPEG compression, blurring, etc.

For more information on SIFT- descriptor along with codes refer to the following link : http://staff.science.uva.nl/~mark/downloads.html#colorsift

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