Michał Podpora
Wydział Elektrotechniki, Automatyki i Informatyki
Instytut Automatyki i Informatyki

YUV VS. RGB – A COMPARISON OF LOSSY COMPRESSIONS FOR HUMAN-ORIENTED MAN-MACHINE INTERFACES

Abstract: In this paper two color spaces, that is YUV and RGB are compared. It is shown that the use of the YUV color space for a particular machine vision implementation gives better image quality of compressed data than that for the RGB color space.

RGB is the most common color space in everyday's electronic devices, though YUV is far more similar to our „biological color space". Rod cells in the retina detect the intensity of light, just like luminance (also called luma channel or „Y" channel). The „black and white" detail has more impact on the image for a human eye because of its rather low color sensitivity. Therefore it should be considered the most useful for image processing. In the YUV color space, chrominance components called "U" and "V" stand for the blue-luminance and red-luminance, respectively.

Since the lossy compression's "distortion" parameter should be modeled on human perception rather than simply as a variance of difference between input and output image, some perceptual distortion measures should be developed. Audio compression perceptual models are relatively advanced (e.g. mp3, ogg), while in image compression they are scarce.

Without perceptual distortion measures, compressing RGB and YUV color spaces images gives comparable quality, while in both of them there are three values describing one pixel. Whereas manipulating with red, green and blue value always gives a perceptibly different image, reducing the chrominance signal quality may pass unnoticed to a human. The idea of chroma subsampling has been formerly used for image coding in YUV formats, e.g. YUV422, but in every case the output image quality was aimed at a human recipient. If the image is to be analyzed by a vision system, the RGB color space is considered to be the most useful source of data. This is not necessarily true. If a robot is supposed to work and to "live" along with human, it can "see" the world the way we do – with similar inaccuracies. The ability of "not recognizing" an object is the key issue of learning and better understanding of the robot's environment.

Converting an image to the YUV color space gives possibility to separate luminance and chrominance signals and to process them independently. Many of the pattern analysis algorithms do not need RGB color space. Some of them work even better on the luminance signal alone.

In Table 1, two representations of an exemplary image are compared. The image is DWT-transformed (discreet wavelet transform) with a specified variable threshold value (threshold function) [3]. Every channel (R,G,B,Y,U,V) is transformed independently to allow fast and easy channels splitting.

Table 1. Comparison of a sample DWT-transformed image with Point-of-Interest [3]. All DWT parameters (e.g. threshold POI function) are equal for both of the analyzed color spaces.

color space	image size [bytes] (DWT&POI) uncompressed	quantity of zeros in processed image (DWT&POI) uncompressed
RGB (RGB888)	196608	178240
YUV (YUV844)	131072	118012

Increasing quantization of chroma channels reduces image size. Compressed YUV image is smaller than RGB image (preserving comparable perceptual quality). If image size reduction is not required, additionally threshold values of the luminance channel can be adjusted to improve perceptual quality while preserving comparable file size.

This research will be used in a currently developed practical implementation to make a vision system and human vision alike. Run-length encoding and entropy-coding are already implemented to allow sending parts of individual frames between computer cluster's nodes. Computer cluster is supposed to enforce CPU power of mobile robot's vision system.

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