4

Representations of colour images in different colour spaces

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Colour spaces (other terms: colour coordinate systems, colour models) are three-dimensional arrangements of colour sensations. Colours are specified by points in these spaces. The colour spaces presented in this chapter are the most popular in the image processing community. Equations describing transformations between different colourspaces and the reasons for using colour spaces other than RGB are presented. Based on examples from the literature, the applicability of individual colour spaces in image processing systems is discussed. Spaces used in image processing are derived from visual system models (e.g. RGB, opponent colour space, IHS *etc.*); adopted from technical domains (e.g. colorimetry: XYZ, television: YUV, *etc.*) or developed especially for image processing (e.g. Ohta space, Kodak PhotoYCC space *etc.*).

4.1 BASIC RGB COLOUR SPACE

The RGB space is the most frequently used colour space for image processing. Since colour cameras, scanners and displays are most often provided with direct RGB signal input or output, this colour space is the basic one, which is, if necessary, transformed into other colour spaces. However, the RGB primaries of these devices are not always consistent. The colour gamut in RGB space forms a cube (Fig. 4.1). Each colour, which is described by its RGB components, is represented by a point and can be found either on the surface or inside the cube. All grey colours are placed on the main diagonal of this cube from black ($R = G = B = 0$) to white ($R = G = B = \max$). When

S. J. Sangwine et al. (eds.), *The Colour Image Processing Handbook*

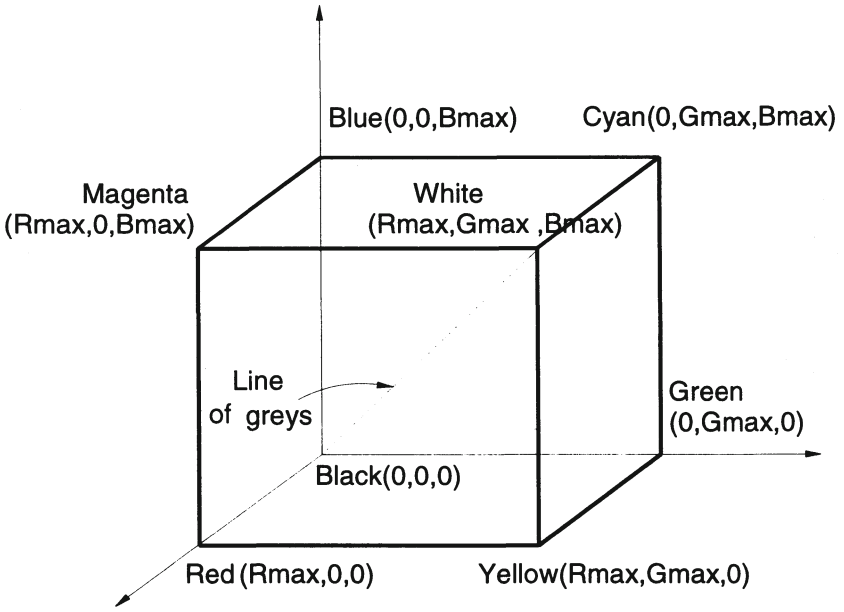

Fig. 4.1 Representation of colour in RGB colour space.

the output signal from a camera is encoded for a TV system, either standard decoders, such as PAL/RGB or NTSC/RGB are used, or the space utilized by a given system is applied, such as YUV space (see section 4.3.1) in the case of the PAL system or YIQ (see section 4.3.2) in the case of the NTSC system. The main disadvantage of RGB colour space in applications involving natural images is a high correlation between its components: about 0.78 for $B-R$, 0.98 for $R-G$ and 0.94 for $G-B$ components. This makes the RGB space unsuitable for compression. Other disadvantages of RGB space are:

- psychological non-intuitivity, i.e. it is hard to visualize a colour based on R, G, B components,
- non-uniformity, i.e. it is impossible to evaluate the perceived differences between colours on the basis of distance in RGB space.

The RGB components for a given image are proportional to the amount of light incident on the scene represented by the image. In order to eliminate the influence of illumination intensity, so-called **chromaticity coordinates**