MORPHOLOGICAL SEGMENTATIONS OF COLOUR IMAGES

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Abstract Colour images are multivariable functions, and for segmenting them one must go through a reducing step. It is classically obtained by calculating a gradient module, which is then segmented as a gray tone image. An alternative solution is proposed in the paper. It is based on separated segmentations, followed by a final merging into a unique partition. Three problems are treated this way. First, the search for alignments in the 2-D saturation/luminance histograms. It yields partial, but instructive results which suggest a model for the distribution of the light over the space. Second, the combination of luminance dominant and hue dominant regions in images. Third, the synthesis between colour and shape information in human bust tracking.

Keywords: colour, segmentation, saturation, norms, light propagation, connection, multivariate analysis

1. Introduction

The present paper aims to analyse the way information is reduced when we go from multi-dimensional colour images to their segmentations, i.e. to final unique optimal partitions [15]. The problem is the following: sooner or later, the processing of such multi-dimensional data goes through a *scalar reduction*, which in turn yields the final partition. Usually, the scalar reduction arises rapidly, since in the most popular procedures it consists in replacing, from the beginning, the bunch of images by a sole gradient module on which the various minimizations hold (e.g. the watershed technique). When the scalar reduction occurs too soon, it risks to ignore specific features of each band, and to destroy them in the melting pot that generates the 1-D variable. The alternative approach we propose here works in the exactly opposite way. We will try and obtain first various intermediary partitions, and then make the final segmentation hold on them.

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This idea is developed below through three studies. The first one extends to colour images the simplest segmentation technique for numerical functions, which consists in histogram thresholding. How to extend it to the 2-D or 3-D histograms of the colour case? The question will be tackled in the framework of the *brightness-saturation-hue* representations. Such polar coordinates have to be defined in a suitable manner for image processing, as A. Hanbury and J. Serra did in [8]. We have also to check the pertinence of these new representations. J. Angulo [2] did it by analysing their 2-D histograms, which exhibit typical alignments. The physical interpretation of these structures leads to an original model for light reception, which is proposed below, in section 3.

The second study relies on the intuition that human vision exploits the hue for segmenting the highly saturated regions, and the luminance for the weakly saturated ones. This way of thinking already appears in literature with C.-H. Demarty and S. Beucher [6], and with P. Lambert and T. Carron [9]. But it is developed here differently, as we seek for an optimal partition by combining the three segmentations of the polar coordinates [1] (section 4).

The third variant enlarges the scope, and aims to synthesize segmentations according to both colour and shape. When we look at a bust, for example, the face of the person presents characteristic colours, whereas the shoulders are better described by their shape. How to mix together such heterogeneous sources? This sort of questions suggests a new model for multi-labelled connections that we will construct on the way (section 5).

The first two studies need a detour, as we have to justify the creation of new parameters (of saturation in particular). A brief remainder on the gamma correction is necessary. An excellent presentation of the theme may be found in Ch. Poynton's book [11], see also [18]. As for the notation, we follow Ch. Poynton, who differentiates by apostrophes the electronic colours (e.g. r') from the light intensities (e.g. r). Below, the rule is extended to the operations themselves; for example the arithmetic mean is written m for intensities and m' for video variables. Also, we adopt the convention of the CIE, which designates the absolute quantities by upper letters (e.g. X, Z) and the relative ones by lower case letters (e.g. x, z).

2. The 3-D polar representations of the colour

Light intensities and gamma correction

Consider a television receiver. It uses three different colour representations. On the one side, the input Hertzian signal is coded as one grey image plus two other ones, associated to green-red and blue-yellow contrasts (i.e. one luminance and two chrominances). On the other side, the image on the monitor is obtained from three electrical signals, which excite three layers of green, red and blue photo-receivers. These two representations are quite different,