A five-stage model for computational color-texture perception

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In this work we present a computational model to deal with colour and texture for automatic image understanding framed in the computer vision field. Instead of regarding just on mathematical or algorithmic requirements, we also intend to base the approach on perceptual considerations, that is, we are working on colour and texture representations that simulate how they are perceived in the human visual system (HVS). We propose to work in five different stages: building an induced image, estimating a global illuminant of the image scene, assigning color names to image points, detecting and grouping blobs, and segregating image regions according to colour-texture appearance. By building an induced image we mean to compute the induction effects on every image pixel, these can be, as a first attempt, assimilation, contrast or adaptation. All these effects will induce a change on the chromaticity or luminance of a pixel depending on the image content. Spatial frequency, chromatic variation and observation conditions are some of the properties to be considered to compute this image transform, which is provided by introducing a perceptual function in a multiresolution decomposition approach. The previous stage is the basis to deal with the interpretation of the scene illuminant, usually referred as the colour constancy ability of the HVS, and which depends on different aspects of the image. In our approach likely illuminants are those which are feasible accordingly with a standard observer sensor and presenting higher matching with more likely surfaces. A third step in the model is based on the colour naming task. In this stage, a colour name is assigned to each pixel of the image, once induction effects have been computed and the illuminant effects have been removed. In our approach the naming task is provided by a fuzzy-set model, and it is the result of fitting psycho-physical data with a triple-sigmoid model. As a fourth step or directly from the induced image from the second stage, a blob detection and grouping stage is needed to deal with texture information. Psychophysical research has provided evidences of the importance of textons in texture perception, where textons can be defined by the image blobs and their attributes. Therefore, in this stage we present an algorithm based on a multi-scale laplacian filtering, followed by a clustering step to perform detection and grouping of blobs respectively. In the last stage, and combining color naming results and blob descriptions, we present a colour-texture grouping stage, in order to segregate image regions sharing common properties. The computational approach to deal with this perceptual grouping is based on the inter-feature distance maps of the outputs of previous stages. To sum up, we can state that the model we have outlined above is presenting a bottom-up approach on how to combine colour and texture, following the classical view of computational Marr's model.