SIMULTANEOUS SMOOTHING AND SHARPENING OF COLOUR IMAGES

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1. INTRODUCTION

Color image processing has became very important over the past few years. In addition to increasing the use of the images in our daily life, constantly emerging fields that requiere techniques for the image improvement. This has ensured the developement of multitude of techniques able to improve the visual quality of the image and extract all kind of information from it.

Color image quality is affected by both acquiring device quality and acquisition conditions. Sensor quality is closely related to the amount of noise in the image whereas both device quality and conditions may limit the definition of image details. Improving image quality is a main issue both for visualization purposes as well as for advanced image processing tasks. In this regard, it is both necessary to remove image noise and improve the definition of image texture and details. Image sharpening is the preprocessing step that approaches the latter target whereas image smoothing deals with the former.

The image sharpening is within the topic of color image enhancement, which encompasses all the techniques whose purpose is the improvement of the image visual appearance and highlight details of the image. To achieving this goal, is very common the application of contrast enhancement techniques such as Histogram equalization, Linear Contrast Streatching [1], or Retinex theory based methods [2]. All this kind of techniques are generally focused on obtaining a more suitable results than the original image version for further image analysis and understanding, for example, to improve an image taken in poor light conditions. If we focus only on raising the borders or details, there are methods, such as Unsharping Mask(UM), but not so numerous as contrast enhancement methods.

In the real life, the images always contain noise, hence in many cases a smoothing step is nedded to achieve certain goals. This is the case of the image sharpening, in many applications we need to enhance the details of the image, for example, for subsequent segmentation or object detection, nevertheless the noise hampers the work of the sharpening techniques. The intuition could lead us to consider two different steps, a first step of smoothing in order to remove the noise, and a second shaperning one or, in reverse order, a first sharpening step and a second smoothing one. These can be easy ways to try to achieve the objetive, given the broad both smoothing and enhancement state of the art. However, these approach can lead to many problems since if we apply a smoothing technique there is the risk of lossing detail or edge information which will not be recovered in the enhancing step. In the other hand, if we apply an enhancing method over a noisy image, we will amplify the noise hampering the subsequent smoothing. In the Figure 1 we can see an example of this two-step approaches.

FIGURE 1. Example of the two-step approach for Parrots image. In the first row, from left to right, the noise-free image, the noisy image, the smoothed image and the result of applying a enhancing method over the smoothed image. In the second row, from left to right, noise-free and noisy image, the enhanced image and finally, the result of smoothing over the enhanced image.

The optimal solution to address this problem is a simultaneous perspective able to sharp the details of the image while remove the noise. However, this is not a simple task given the opposite nature of these two operations. There is a close relation bewteen the noise and the details, both correspond to high frequencies, and we want to remove the noise at the same time as we increase the details. Some authors have tried to address this problem, in general for gray-scale images, by using differents approaches: through Forward-and-backward diffusion [3], by Block-matching and 3D filtering [4], by using different reformulations of the classical Bilateral Filter such as Adaptive Bilateral Filter [5] or Guided Image Filetering [6, 7] or by Adaptative Unsharping Mask [10]. Nevertheless, although the state of the art concerning smoothing or enhancement is very extensive, there are currently not many methods able to address with both methods in a simultaneous way.

We propose a new model which enable the smoothing of the noise at the same time that enlarge the borders. The image is modelized by using graph theory and then the model allows to separate, in a highly efficient way even in the presence of noise, the homogeneous and the borders regions of the image. This characterizations allow us to operate appropiately in each zone for smoothing or sharpening according to the pixel nature.

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