Abstract

Typically, conventional image-enhancement methods have a common problem concerning the over-enhancement in an image which contains both less-visible and nicely-visible areas, while preserve such the key-lighting of image or the tone of original image. To solve such problem, we propose two new less-visible-image enhancement schemes, called the less-visible contrast enhancement method (LVCE) and the less-visible contrast enhancement based on human visual perception (LVCEHP). For the LVCE, we propose a new contrast enhancement method based on the singular value decomposition (SVD), an adaptive non-linear scaling function, and a pyramid-based blending method. The SVD is used to decompose an image into several. Based on our investigation, we found that some layers are associated with the less-visible area. Then, the less-visible layers are selected and enhanced by using the proposed logarithm-function. For the LVCEHP, we propose a new contrast enhancement method based on several principles of visual human perception such as the Weber's law in image contrast and the Just-Noticeable-Different (JND). At the beginning, we study the principle of image contrast. Based on this study, we found that the human perception is more sensitive to image contrast rather than absolute luminance values.

The original idea of LVCEHP is to enhance an image by applying several principles of visual human perception such as the Weber's law in image contrast and the Just-Noticeable-Different (JND) to create the algorithm. Then, we apply definition of the Weber's contrast to the proposed non-scaling function. By investigating the characteristic of the Weber's equation, there are three possible cases that could be occurred in the entire image. We used these cases as the inspiration to calculate the enhancement rate of the proposed non-linear scaling function. We also use the principle of JND in the image to guarantee that the less-visible areas perceived discriminatory from the previous ones too. Moreover, we used the principle of singular value decomposition (SVD) to propose a new technique for analyze and remove the hidden noise of the input image. We experimentally found that the smaller area-bounded of the singular-value curve implies the higher level of noise. If the area of singular value contains the area-bounded less than the threshold value of the hidden noise value. Then, we remove the noise layer before the enhancement process. Lastly, to recover the nicely-visible area, we propose the pyramid-based blending techniques for fusing two images in order to solve the problem of information missing in the blending process. This recovery process is mandatory because enhancing images in the previous step might cause the over-enhancement. Objective and subjective evaluations were conducted, and experimental results show that our proposed method can successfully improve the less-visible contrast without amplifying noise. It also preserves the tone and texture of original images and produces satisfying results in terms of human preference.

Keywords: less-visible contrast enhancement, human visual perception, singular value decomposition, pyramid-based blending, just-noticeable-different