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Image enhancement using IGM and improved PCNN

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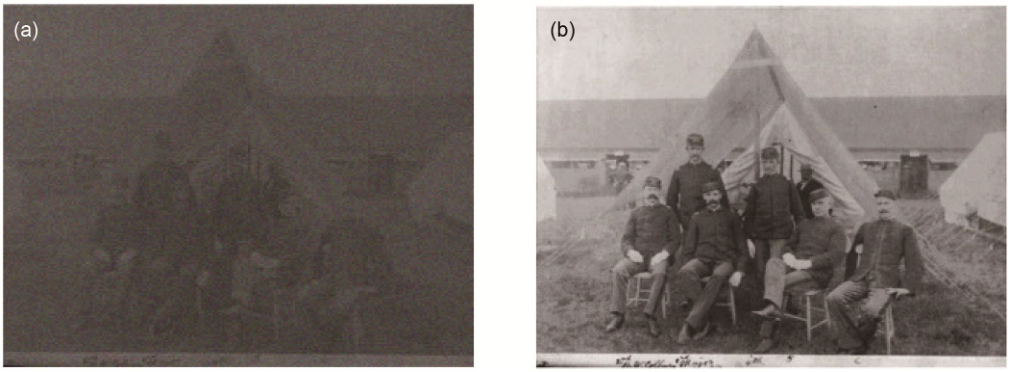

One of the experimental results in this paper. (a) The degraded image. (b) The experimental result.

Abstract: Image enhancement is an important and fundamental problem for image processing. However, there are some images that the visual system obtained with a mass of effective features loss, appearing to be low contrast and high noise, which will affect the image enhancement and the subsequent processing of computer vision applications. To deal with the low-contrast and high-noisy natural images, an image enhancement method based on internal generative mechanism (IGM) and improved pulse coupled neural network (PCNN) is proposed. First, in the division operation, an image is segmented into two parts using the theory of IGM. One part is a rough sub-graph, which contains the basic information of the images, and the other is a detail sub-graph, which contains the image details. Second, in order to make the rough sub-graph more clearly, an improved PCNN enhancement method with fuzzy sets is adopted. As we all know, the I_{ij} in PCNN represents the working state of each neuron and every neuron has its own I_{ij}. So we use the I_{ij} as the input of the fuzzy function to obtain the fuzzy membership. Subsequently, through the successive iteration of the fuzzy membership, we have achieved the purpose of using this information to non- linearly extend the I_{ij}, and then, the image contrast of the target and background is enhanced accordingly. At the same time, β_{ij} in PCNN affects the ignition cycle between the central neuron and the neighborhood neurons, which in turn affects the gray value of the pixels. By improving the calculation method of β_{ij} in PCNN, we have achieved the purpose of sharpening the image edge and removing the noises of the detail sub-graph. Finally, the final image is reconstructed by the processed rough sub-graph and detail sub-graph. To verify the effectiveness and superiority, we design three sets of controlled experiments which are performed on some PCNN enhancement algorithms, including the original PCNN method in Ref.[7], the improved PCNN methods in Ref.[8] and Ref.[9]. Meanwhile, we choose three classic images to show the experiment results qualitatively, and the results are shown in Fig. 4, Fig. 5 and Fig. 6. After that, in order to show the quantitative experiment results, we also chose five reference and no-reference image quality assessment methods, such as the DV/BV, SSIM, entropy, SNR, and EPI, to compare the effect of various image enhancement methods. Experimental results show that the proposed algorithm can effectively enhance the image contrast and image contour, as well as filter out some noise without any loss of image edges.

Keywords: internal generative mechanism; pulse coupled neural network; fuzzy sets; image enhancement

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