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Image Enhancement for Face Recognition

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This paper considers procedures for enhancement of images, which are of low contrast, dark or bad lighting. Image pre-processing and normalization is significant part of face recognition systems. Changes in lighting conditions produces dramatically decrease of recognition performance. We present image enhancement procedures for face recognition, both wide spread and developed by us.

Introduction

Image pre-processing and normalization is significant part of face recognition systems. Changes in lighting conditions produces dramatically decrease of recognition performance.

If an image is low contrast and dark, we wish to improve its contrast and brightness. The widespread histogram equalization cannot correctly improve all parts of the image. When the original image is irregularly illuminated, some details on resulting image will remain too bright or too dark.

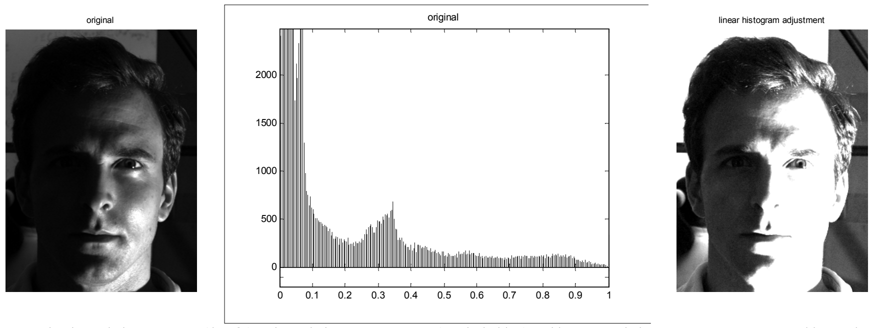

Fig. 1. An original image (left), its histogram (middle), linear histogram equalization (right).

1) Adaptive contrast enhancement

The idea is to enhance contrast locally analyzing local grey differences taking into account mean grey level. First we apply local adaptive contrast enhancement. Parameters are set to amplify local features and diminish mean brightness in order to obtain more contrast resulting image. After that we apply histogram equalization.

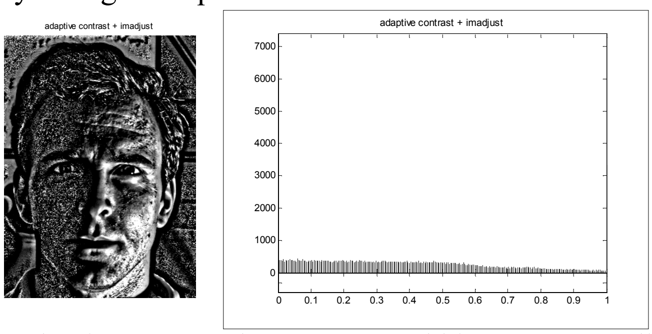

Fig. 2. Result of contrast enhancement and histogram equalization.

2) Nonlinear histogram equalization

The main drawback of linear histogram equalization is that it is a global procedure, there is no warranty of good result. We tested non-linear histogram equalization, which performance is better under large variety of images and it did not require manual selection of parameters. The performance of nonlinear histogram equalization is not worse than performance of linear histogram equalization under carefully chosen parameters.

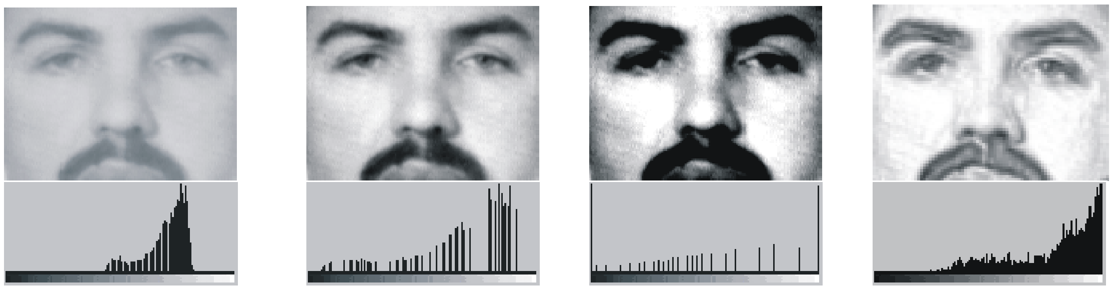

Fig. 3. Original image (left) and result of nonlinear histogram equalization with different parameters (middle), result of highboosting (right) with histograms in the second row.

3) Highboosting

Highboosting operator is another operator combining local pixel properties: gradient information and grey value. Resulting image has more contrasted edges and uniform brightness.

4) Local histogram equalization

The image pre-processing may be used for different goals. For example for manual or automatic image processing. So we have developed another image enhancement procedure, the local histogram equalization. The main idea is to take into account histogram distribution over local window and combine it with global histogram distribution. We have used nonlinear histogram equalization for combination of local and global histogram.

The result for above mentioned original image is:

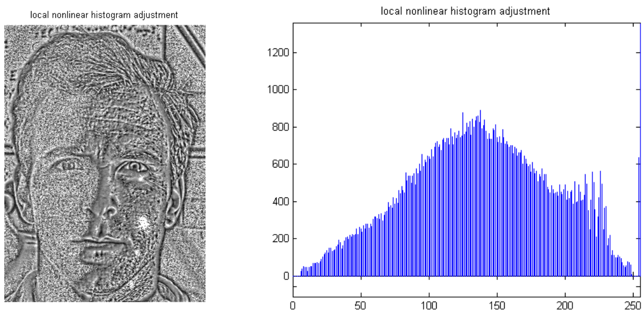

Fig. 4. Result of local nonlinear histogram equalization.

As we can see, local histogram equalization produce less noise than adaptive contrast enhancement, but also image is less sharp.

5) Gamma correction

Gamma correction operation performs nonlinear brightness adjustment. Brightness for darker pixels is increased, but it is almost the same for bright pixels. As result more details are visible.

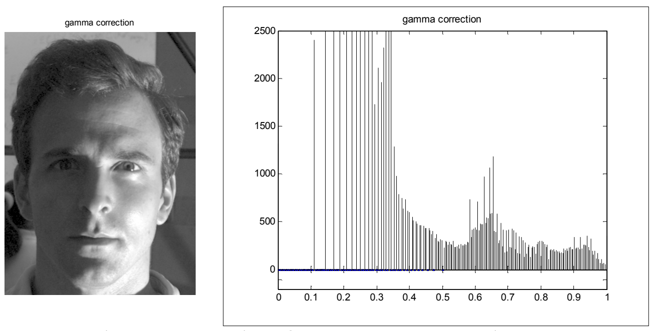

Fig. 5. Result of gamma correction.