figures/qr-code.png

Adaptive Histogram Equalization

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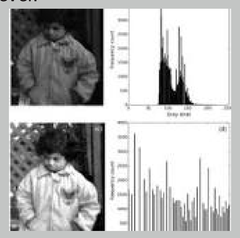
Abstract

- Histogram equalization is a method to process images in order to adjust the contrast of an image by modifying the intensity distribution of the histogram.
- It is often used to achieve better quality images in black and white color scales in medical applications such as digital X-rays, MRIs, and CT scans.
- Histogram equalization fails when the input image (a) has a large area low-intensity background. In this case, the histogram (d) has a spike component corresponding to the background graylevel.

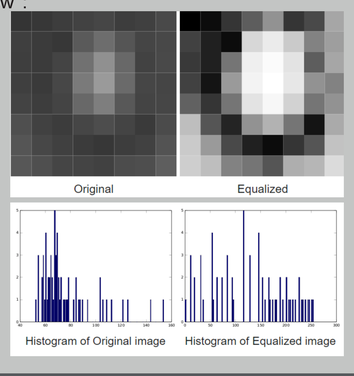


How Does It Work

- This method can lead to better views of bone structure in x-ray images, and to better detail in photographs that are either over or under-exposed. A key advantage of the method is that it is a fairly straightforward technique adaptive to the input image and an invertible operator.
- The histogram graph depends on pixel intensities of input image. We have to make cummulative distributive frequency(cdf) to perform histogram equalization. To get the pixel intensities after equalization, we should apply

$$h(v) = \text{round}\left(\frac{\text{cdf}(v) - \text{cdf}_{\text{min}}}{(M \times N) - \text{cdf}_{\text{min}}} \times (L-1)\right)$$

- The result and their histogram graphs will be obtained as shown below :

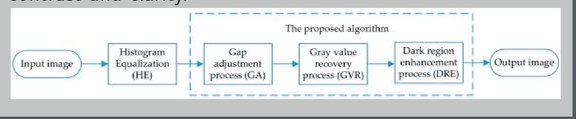


Introduction

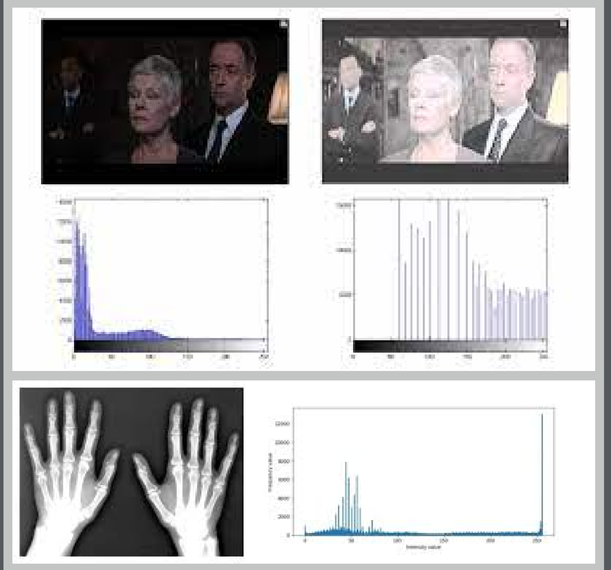
- Histogram equalization is also called as "Histogram Linearisation".
- Histogram Equalization is an image processing technique that adjusts the contrast of an image by using its histogram. To enhance the image's contrast, it spreads out the most frequent pixel intensity values or stretches out the intensity range of the image.
- This technique is most popular because it is easy to implement and fast processing.
- However, this technique produces many drawbacks such as it adds noise to the output image, increasing the contrast of its background and the signal gets distorted.

Algorithm

- "HE" is a simple and effective method for improving image contrast. However, it may cause the over-enhancement and feature loss problems.
- The reason for this problem is that HE stretches the gaps of the histogram between two adjacent gray values to a great extent as shown in Figure 1d, thus leading to over enhancement. In this paper, the term "gap" denotes the number of gray levels between two neighboring gray values.
- Further, CegaHE can enhance the textures in the dark regions of the images and make them clearer.
- CegaHE is a HE-based method. The three major processes in CegaHE are as follows:
- Gap adjustment process (GA): This process adjusts the gaps between two neighboring gray values in the HE histogram to alleviate the over-enhancement problem produced by HE.
- Gray value recovery process (GVR): This process alleviates the feature loss problem produced by HE. The GVR uses free pixels to recover the lost features.
- Dark region enhancement process (DRE): The image quality is poor, especially when the light is dim or insufficient. To compensate for this effect, the process enhances the textures in the dark regions of the images, and increases their contrast and clarity.



Results



Conclusion

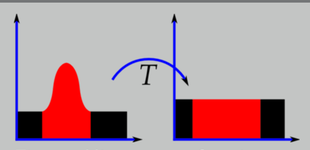
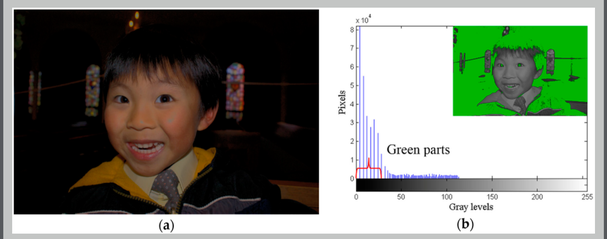


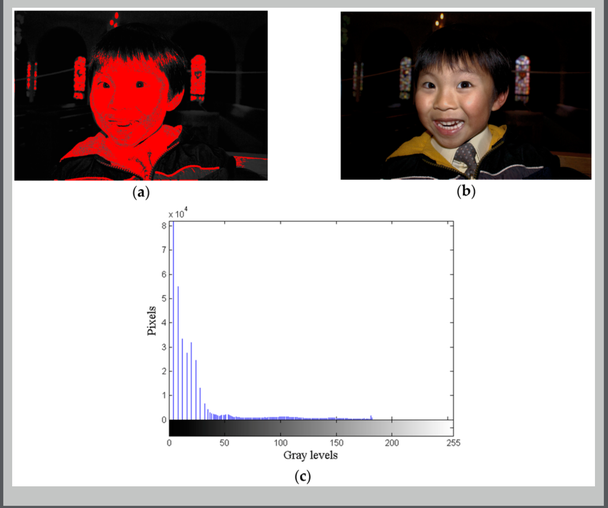
Figure: Histogram of an image before and after equalization

- The goal of histogram equalization is to produce an output image that has a flattened histogram, the goal of histogram matching is to take an input image and generate an output image that is based upon the shape of a specific (or reference) histogram. Histogram matching is also known as histogram specification.
- Both histogram equalization and histogram streching are used to enhance contrast more precisely. But during histogram equalization the overall shape of the histogram changes, whereas in contrast stretching the overall shape of histogram remains same.
- It is often used to illustrate the major features of the distribution of the data in a convenient form.
- It is also useful when dealing with large data sets (greater than 100 observations). It can help detect any unusual observations (outliers) or any gaps in the data.

Gap Adjustment Process (GA)



Gray Value Recovery Process (GVR)



Dark Region Enhancement Process (DRE)