

Contrast Enhancement Overview

Abstract

In some digital images, the features of interest occupy only a relatively narrow range of the gray scale. One might use a point operation to expand the contrast of the features of interest so that they occupy a larger portion of the displayed gray-level range. This is called a Contrast enhancement or Contrast Stretching. This paper is discussed about The way of Contrast Enhancement.

Keywords: Grey Scale, Enhancement and Contrast Stretching.

Introduction

Gray level values may are between 0 and 255, but may be concentrated in the middle of the range. All of the gray values shown are between 147-152. The values in this original image are so similar that the eye cannot tell the difference between them. This range of six values is much smaller than the 256 digital values possible. In order to see the differences in the image the contrast range needs to be changed so that the lowest gray value is dark, and the highest gray value is light. Let us take some matrix of an image as.



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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 151 | 151 | 151 | 152 | 152 | 204 | 204 | 204 | 255 | 255 |
| 150 | 151 | 151 | 151 | 152 | 153 | 204 | 204 | 204 | 255 |
| 150 | 150 | 150 | 151 | 151 | 153 | 153 | 153 | 204 | 204 |
| 146 | 149 | 149 | 150 | 151 | 102 | 102 | 102 | 153 | 204 |
| 148 | 147 | 148 | 150 | 151 | 51 | 0 | 51 | 153 | 204 |
| 148 | 148 | 148 | 150 | 150 | 51 | 51 | 51 | 153 | 153 |

A simple equation shows the procedure enhancing an image is. Let us take a value $g_1(x,y) = 147$ is to be stretched as

$$[(g(x,y) - \text{MIN gray value}) / (\text{MAX gray value} - \text{MIN gray value})] * 255$$

$$(147-147)/(152-147)*255 = 0 \text{ or } [(152-147)/(152-147)]*255 = 255$$

The scaling of the gray level values in an image to make hidden information visible is called **contrast stretching**. Contrast stretching is to increase the dynamic range of the gray levels in the image. In this way the actual information in the image does not change, however we will be able to see the image more clearly. Transformation is used to enhance low contrast images. In a low contrast image specific details are difficult to determine due to the fact that most pixels are at the same intensity value. Contrast stretching resolves this problem by boosting the lighter pixels to a higher intensity level, and doing exactly the opposite to the lower intensity pixels.

The process of taking the original data numbers and changing them to new values is called *mapping*. A mathematical description of the mapping is called a *mapping function*.

Linear mapping

We can adjust the overall brightness of a gray scale image simply by adding a constant bias, b to pixel values:

$$g(x,y) = f(x,y) + b \tag{1}$$

If $b > 0$, overall brightness is increased:

if $b < 0$, it is decreased.

The operation merely shifts the gray level values of all pixels up or down. The effect of this is to make the entire image appear darker or lighter when displayed.

Similarly, we can adjust contrast in a gray scale image through multiplication of pixel values by a constant gain, α :

$$g(x,y) = \alpha f(x,y) \tag{2}$$

If $\alpha > 1$, contrast is increased, whereas if $\alpha < 1$ it is reduced. If α is negative, dark areas become light, light areas become dark.

We can combine two equations (1) and (2) to give a general expression for brightness and contrast modification. In this case, the gray scale transformation function takes the form:

$$g(x,y) = T[f(x,y)] = \alpha f(x,y) + b \tag{3}$$

This is linear mapping of pixel gray level

Often, we do not want to specify a gain and a bias, but would rather map a particular range of gray levels $[f_1, f_2]$, onto a new range $[g_1, g_2]$. The formula for mapping is, Where $f(x, y)$ is intensity to be transformed.

$$g(x, y) = g_1 + \left(\frac{g_2 - g_1}{f_2 - f_1} \right) [f(x, y) - f_1]$$

In general the locations of point $(f_1(x, y), g_1(x, y))$ and $(f_2(x, y), g_2(x, y))$ control the shape of the transformation function.

1. If $f_1(x, y) = g_1(x, y)$ and $f_2(x, y) = g_2(x, y)$ —the transformation is linear that produces no changes in gray level.
2. If $f_1(x, y) = f_2(x, y)$, $g_1(x, y) = 0$ and $g_2(x, y) = 255$ —the transformation becomes a thresholding function that creates a binary image.
3. Intermediate values of (f_1, g_1) and (f_2, g_2) produce various degrees of spread in the gray levels of the output image, thus effecting its contrast.

(see Digital Image Processing a practical introduction using Java, Gray Map Tool)

Non -Linear Mapping

Non-linear mapping functions have a useful property. Sometimes the dynamic range of a processed image far exceeds the capability of the display device, in which case only the brightest parts of the image are visible on the display screen. An effective way to compress the dynamic range of pixel values is to perform **the logarithmic intensity mapping** (transformation) function

$$g(x, y) = c \log(1 + |f(x, y)|) \quad (5)$$

where c is a scaling constant, and the logarithm function performs the desired compressing of dynamic range.

The gain, applied to input grey levels— as measured by the slope of a tangent to the function— can vary. Thus the way in which contrast is modified depends on input grey level. For example we can use logarithmic mapping function and two ranges of input grey level, Δf_1 and Δf_2 , of equal width, are shown. Range Δf_1 , which occurs at low gray level, is mapped onto a wider range, Δg_1 : thus, contrast is increased. However, at the high end of the scale, $\Delta g_2 < \Delta f_2$ — so contrast is reduced here.

Logarithmic mapping is useful if we wish to enhance detail in the darker regions of the image, at the expense of detail in the brighter regions.

Applying exponential mapping of gray level, the effect is the reverse of that obtained with logarithmic mapping; contrast in the brighter parts of an image is increased at the expense of contrast in the darker parts. In this case $\Delta g_1 < \Delta f_1$ and $\Delta g_2 > \Delta f_2$.

We also can use square root function as a non-linear transformation of gray level

Conclusion

Gray level mapping used to adjust brightness and/or contrast of an image. Logarithmic function is used to enhance the images taken in dark. Contrast image enhancement; enhance a photographic image, image taken in Dark, cloudy image rainy image and so on. Now a days image technique play a important role in medical image for best diagnose, in the fields of space and aeronautical research.

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