Digital Image Processing Learning

The third section

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Contents

Purpose

We want to:

Contrast manipulation and image thresholding Intensity Transformation

Performing operations Spatial filtering

Some Basic Intensity Transformation Functions

linear Image Negatives, $s = L - 1 - r$.

Enhance white or gray detail embedded in dark regions of an image.

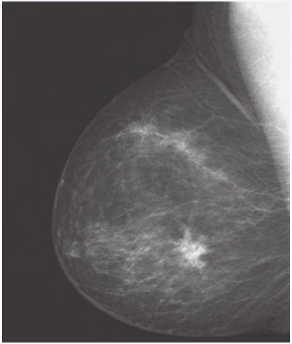


Figure1(a), Original picture

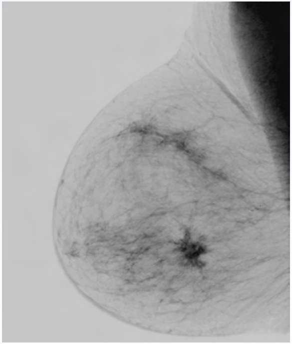


Figure1(b), Using the negative transformation

Some Basic Intensity Transformation Functions

Logarithmic Log transformation, $s = clog(1 + r)$.

We use this type to expand the values of dark pixels in an image while compressing the higher-level values.

Some Basic Intensity Transformation Functions

Power-law Power-Law(Gamma)transformstions, $s = cr^{\gamma}$.

Depend on γ.

Figure2(a), Original picture

Figure2(b), $\gamma = 0.5$

Some Basic Intensity Transformation Functions

Piecewise-Linear Transformationn Functions Advantage: can be arbitrarily complex.
Disadvantage :their specification requires considerably more user input.

Histogram Processing

For image enhancement.
Normallize a histogram:$p(r_k) = n_k/MN$, for $k = 0, 1, ...L-1$, p_k is an estimate of the probability of occurrence of intensity level r_k in an image.The sum of all components of a normalized histogram is equal to 1.

Histogram Equalization

Spread the histogram of the input image so that the intensity levels of the equalized image span a wider range of the intensity scale.The net result is contrast enhancement. The results are predictable and method is simple to implement.
Equations:

$$p_r(r_k) = \frac{n_k}{MN}, k = 0, 1, 2 \ldots, L-1 \tag{1}$$

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j) = \frac{(L-1)}{MN}\sum_{j=0}^{k} n_j, k = 0, 1-2 \ldots, L- \tag{2}$$

Histogram Equalization

Figure3(a), Original picture

Figure3(b), Equalization

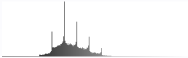


Figure3(c), Original histogram

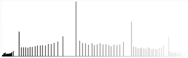


Figure3(d), Histogram after equalizing

Histogram matching

The method used to generate a processed image that has a specified histogram.
Major equations:

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j) = \frac{(L-1)}{MN}\sum_{j=0}^{k} n_j, k = 0, 1, 2 \ldots, L-1 \tag{3}$$

$$G(z_q) = (L-1)\sum_{i=0}^{q} p_z(z_i) \tag{4}$$

Histogram matching

$$G(z_q) = s_k \tag{5}$$

$p_z(z_i)$ is the ith value of the specified histogram.

$$z_q = G^{-1}(s_k) \tag{6}$$

Local Histogram Processing

Enhance details over small areas in an image.

Using Histogram Statistics for Image Enhancement

The mean and variance are used as the basis for making changes.

Fundamentals of Spatial Filtering

Spatial filters can be used also for nonlinear filtering, something we cannot do in the frequency domain. Linear spatial filtering of an image of size $M * N$ with a filter of size $m * n$ is given by the expression:

$$g(x, y) = \sum_{s=-a}^{a} \sum_{t=-b}^{b} w(s, t) f(x + s, y + t) \tag{7}$$

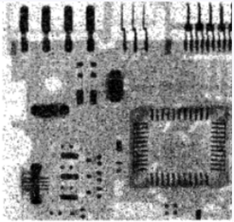
Smoothing Linear Filters

Smoothing filters are used for blurring and for noise reduction.
The output(response) of a smoothing, linear spatial filter is the average of the pixels contained in the neighborhood of the filter mask.
Sometimes are called averaging filters.Refer to a lowpass filters.
A major use of averaging filters is in the reduction of " irrelevant" detail in an image.

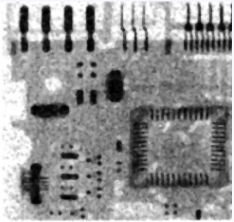
Order-Statistic(Nonlinear) Filters

The best-known filter is the medium filter.
Median Filters are particularly effective in the presence of impulse noise, also called salt-and pepper noise.

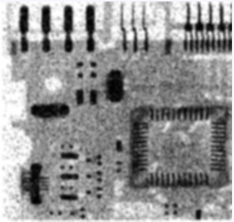
Dealing with noise



Original image



Median filter



Average filter

Sharpening Spatial Filters

Highlight transitions in intensity.
Using the the Laplacian for Image Sharpening

$$\frac{\partial^2 f}{\partial x^2} = f(x+1) + f(x-1) - 2f(x) \tag{8}$$

$$\frac{\partial^2 f}{\partial y^2} = f(y+1) + f(y-1) - 2f(y) \tag{9}$$

$$\bigtriangledown^2 f = f(x+1, y) + f(x-1, y) + f(x, y+1) + f(x, y-1) - 4f(x, y) \tag{10}$$

$$g(x, y) = f(x, y) + c[\bigtriangledown^2 f(x, y)] \tag{11}$$

Sharpening Spatial Filters

The Laplacian is used for highlights intensity discontinuities in an image.This will tend to produce images that have grayish edge lines and other discontinuities, all superimposed on a dark, featureless background. Background features can be ”recovered” while still preserving the sharpening effect of the Laplacian simply by adding the Laplacian image to the original.

Unsharp Masking and Highboost Filtering

A process that has been used to sharpen images consists of subtracting an unsharp(smoothed) version of an image from the original image.Then add the difference.

Combining Spatial Enhancement Methods

Combine several approaches.

汇报:

1. 对于内容的理解。
2. 形式的展示，觉得需要的内容就放上，但可以快速讲过，最好是加上个人的理解与体会而不是照搬书本。汇报如何吸引人?
3. 发现问题，寻找解决问题的上路，方法，发现问题后深入思考下去。

平时:

1. 把不会的表达出来。
2. 学习内容上的深度交流。
3. 报告形式上多学习，多问。