Image quantization

Image quantization is the process of reducing the image data by removing some of the detail information by mapping group of data points to a single point. This can be done by:

1. Gray Level reduction (reduce pixel values themselves I(r, c).
2. Spatial reduction (reduce the spatial coordinate (r, c).

The simplest method of gray-level reduction is Thresholding. We select a threshold gray _level and set every thing above that value equal to "1" and every thing below the threshold equal to "0". This effectively turns a gray level image into binary (two level) image and is often used as preprocessing step in the extraction of object features, such as shape, area, or perimeter.

A more versatile method of gray _level reduction is the process of taking the data and reducing the number of bits per pixel. This can be done very efficiency by masking the lower bits via an AND operation. Within this method, the numbers of bits that are masked determine the number of gray levels available.

Example:

We want to reduce 8_bit information containing 256 possible gray_level values down to 32 possible values.

This can be done by ANDing each 8-bit value with the bit string 1111100.

this is equivalent to dividing by eight(2^3), corresponding to the lower three bits that we are masking and then shifting the result left three times. [Gray _level in the image 0-7 are mapped to 0, gray_level in the range 8-15 are mapped to 8 and so on].

We can see that by masking the lower three bits we reduce 256 gray levels to 32 gray levels:

256 ÷ 8= 32

The general case requires us to mask k bits, where 2^k is divided into the original gray-level range to get the quantized range desired. Using this method, we can reduce the number of gray levels to any power of 2: 2,4,6,8, 16, 32, 64 or 128.

 Image quantization by masking to 128 gray level, this can be done by ANDing each 8-bit value with bit string 11111110(2^1).

 Image quantization by masking to 64 gray_level. This can be done by ANDing each 8-bit value with bit string 11111100(2^2).

As the number of gray levels decreases, we can see increase in a phenomenon called contouring.

Contouring appears in the image as false edges, or lines as a result of the gray _level quantization method.

Original 8-bit image,
256 gray levels

Quantized to 6 bits,
64 gray levels

Quantized to 3 bits,
8 gray levels

Quantized to 1 bits,
2 gray levels

This false contouring effect can be visually improved upon by using an IGS (improved gray-scale) quantization method. In this method (IGS) the improvement will be by adding a small random number to each pixel before quantization, which results in a more visually pleasing appearance.

2- Quantization of Spatial Coordinates Methods

In this methods, the size of image will decrease by tacking the pixel and it's neighbors and convert it to one pixel. there are three methods for quantization spatial coordinates

a) Average method: in this method we take the average of the gray levels pixels with determine mask size on the original image.
b) Median: in this method the pixels in mask will sort in descent and take the pixel in the middle.
c) Decimation or Down sampling: in this method, the pixels will neglected by factor k (for example if k=2) we take every row and column and neglect the other.