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## المحاضرة العاشرة

# Image quantization

**المادة : DSP**
**المرحلة : الثالثة**
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## 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 everything above that value equal to "1" and everything below the threshold equal to "0". This effectively turns a gray level image into a binary (two level) image and is often used as a 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 1:** We want to reduce 8bit information containing 256 possible gray level Values down to 32 possible values. 8 bit = $2^3$

This can be done by ANDing each 8-bit value with the bit string **11111000.** 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 8-15are mapped to 8 and so on].

We can see that by masking the lower three bits we reduce 256 gray levels to32 gray levels:

**256 ÷ 8= 32**

The general case requires us to mask k bits, where ($2^k$) is divided into the original graylevel 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 graylevel. This can be doneby

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.

**Example 2 :** We want to reduce 8-bit information containing (256 possible gray level) value down to 4 possible values.

AND-MASK

Sol.\

1- Determine (n) value:

256 gray level ⟶ 4 gray levels.

$2^8 \longrightarrow 2^2$

n = 2

2- Extract mask:

mask = 256 - $2^{8-n}$

= 256 - $2^{8-2}$

= 256 - $2^6$ =256 - 64

mask = 192

Let g = 212

$2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | = 212 |
| And | | | | | | | | |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | = 192 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | = 192 |

3-Shift to right

no. of shift right = 8 – n

= 8 – 2 = 6

>> 6

0 0 0 0 0 0 1 1 = 3

One of black level

$x = \text{result value} * \frac{256}{4}$

$= 3 * \frac{256}{4}$

$= 192$

One of white level

**Example 3 :** We want to reduce 8-bit information containing (256 possible gray level) value down to 4 possible values.

OR – MASK

Sol.\

1- Determine (n) value:

256 gray level ⟶ 4 gray level

$2^8 \longrightarrow 2^2$

$n = 2$

2- Extract mask:

$mask = 2^{8-n} - 1$

$= 2^{8-2} - 1$

$= 2^6 - 1 = 64 = 63$

mask = 63

Let g = 212

| $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | |
|---|---|---|---|---|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | = 212 |

OR

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | = 63 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | = 255 |

3- Shift to right

no. of shift right = 8 – n

= 8 – 2 = 6

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

>> 6

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | = 3 |

One of black level

$x = \text{result value} * \frac{256}{4}$

$= 3 * \frac{256}{4}$

$= 192$

One of white level

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

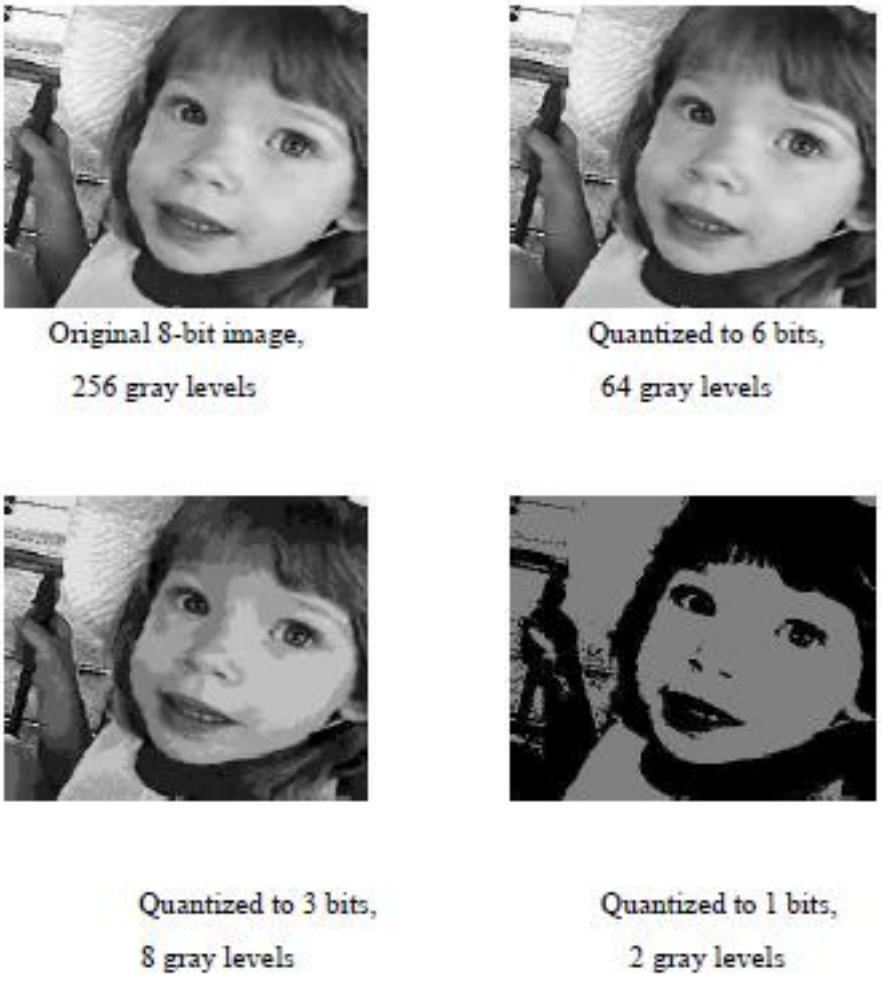


**Figure (1 ) False Contouring .**

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.

Original Image

Uniform quantization

to 8 levels (3 bits)

IGS quantization

to 8 levels (3 bits)

**Figure (2 ) IGS quantization .**