جامعة المستقبل
AL MUSTAQBAL UNIVERSITY

قسم الامن السيبراني
DEPARTMENT OF CYBER SECURITY

SUBJECT:

IMAGE PROCESSING

CLASS:

THIRD

LECTURER:

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LECTURE: (6)

IMAGE QUANTIZATION

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 :

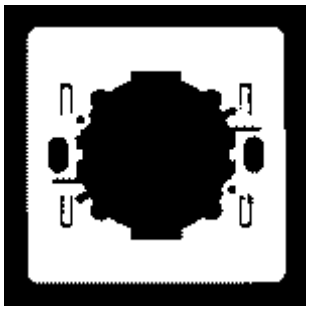
1. Gray_Level reduction (reduce pixel values themselves I(r, c).
2. Spatial reduction (reduce the spatial coordinate (r, c).

Gray_Level reduction (reduce pixel values themselves I(r, c).

- The simplest method of gray-level reduction is **Thresholding**. We select a threshold gray _level (T) 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.

$$B(i,j) = \begin{cases} 1 & if\ f(i,j) > T \\ 0 & otherwise \end{cases}$$

Gray scale image



Binary image

- 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 .

And Method

0 ----- 31 = 32 possible value.

X= 256 ÷ 32= 8 $8=2^3$ **k=3** **masking the lower three bits (000)**

Mask=256-x **Mask=11111000**

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 8-15 are mapped to 8 and so on].

EX/

$(222)_{10}=(11011110)_2$

ANDing with 11111000

$= (11011000)_2 = (216)_{10}$

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

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: 2,4,8 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).

Or Method

0 ----- 31 = 32 possible value.

X= 256 ÷ 32= 8 $8=2^3$ **k=3** **highlight the lower three bits (111)**

Mask=x -1 **Mask=00000111**

This can be done by ORing each 8-bit value with the bit string (**00000111).**

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

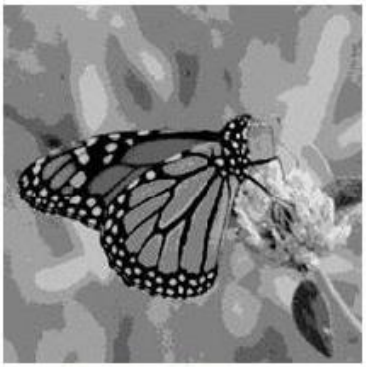
Quantized to 6 bits,
64 gray levels

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.

Original Image



Uniform quantization
to 8 levels (3 bits)

IGS quantization
to 8 levels (3 bits)

Image Quantization Questions— MCQs

1. What is the primary goal of image quantization?
2. Which of the two main methods for image quantization involves Gray-Level reduction?
3. Gray-Level reduction involves reducing which aspect of the image data?
4. Spatial reduction involves reducing which aspect of the image data?
5. What is the simplest method of gray-level reduction mentioned in the lecture?

Thresholding

6. In the thresholding method, if a pixel's gray level f(i,j) is greater than the threshold T, what is the output B(i,j) set to?
7. Thresholding effectively turns a gray-level image into what type of image?
8. Thresholding is often used as a preprocessing step for the extraction of what kind of object information?

Gray-Level Reduction by Masking (AND Method)

9. What is the more versatile method of gray-level reduction that involves reducing the number of bits per pixel?
10. The gray-level reduction method using an AND operation is done by masking which part of the bits?
11. If you reduce an 8-bit image (256 gray levels) down to 32 possible gray levels using the AND method, how many lower bits (k) must be masked?
12. What is the 8-bit mask used to reduce 256 gray levels down to 32 using the AND method?
13. In the AND method, masking the lower k bits is equivalent to dividing the pixel value by 2k and then performing which bitwise operation?
14. Using the masking method, the number of gray levels can be reduced to any power of two—list the possible options for an 8-bit image.
15. To quantize an 8-bit image to 128 gray levels using the AND method, what is the required bit string (mask)?
16. If an 8-bit gray level of 222 (binary 11011110) is ANDed with the mask 11111000, what is the resulting binary value?
17. Reducing the gray levels in an 8-bit image to 64 levels requires ANDing each pixel value with what bit string?

Gray-Level Reduction by Masking (OR Method) and Contouring

18. In the OR method for gray-level reduction to 32 levels, what is the 8-bit mask used?
19. The OR method uses the mask to perform which specific action on the lower three bits?
20. As the number of gray levels decreases during quantization, a phenomenon called what can increase?
21. How does the contouring phenomenon appear in the image?
22. An image quantized to 1 bit results in how many gray levels?

Improved Gray-Scale (IGS) Quantization

23. The false contouring effect caused by quantization can be visually improved upon by using which method?
24. What step is added to each pixel before quantization in the IGS method to achieve visual improvement?
25. The IGS quantization method is primarily used to address which visual artifact caused by uniform quantization?