IMAGE QUANTIZATION

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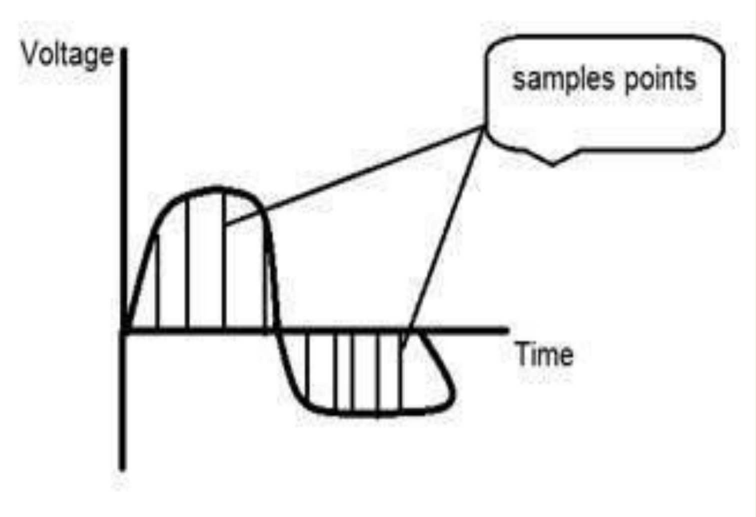
Introduction

- As we have seen in the previous lectures Ch.1, that digitizing an analog signal into a digital, requires two basic steps.

[Sampling and quantization.]

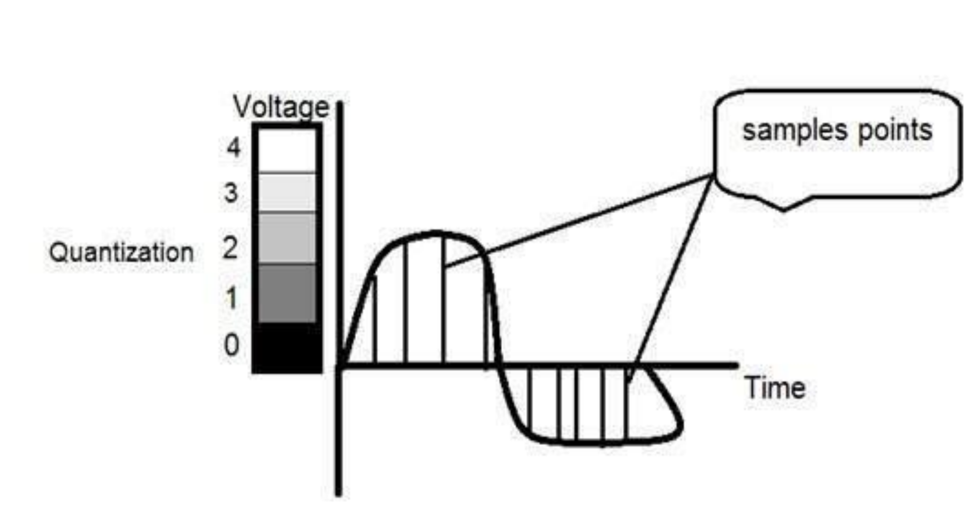
- Sampling is done on x axis. It is the conversion of x axis (infinite values) to digital values.
- The below figure shows sampling of a signal.
- The more samples you take, the more pixels, you get



What is quantization

- Quantization is opposite to sampling. It is done on y axis. When you are quantizing an image, you are actually dividing a signal into quanta (partitions).
- On the x axis of the signal, are the co-ordinate values, and on the y axis, we have amplitudes.
- So digitizing the amplitudes is known as **Quantization.**

- In the figure shown above, these vertically ranging values have been quantized into 5 different levels or partitions. Ranging from 0 black to 4 white



Relation of Quantization with gray level resolution:

- The quantized figure shown above has 5 different levels of gray.
- It means that the image formed from this signal, would only have 5 different colors. It would be a black and white image more or less with some colors of gray.
- Now if you were to make the quality of the image more better, there is one thing you can do here. Which is, to increase the levels, or gray level resolution up.
- If you increase this level to 256, it means you have an gray scale image. Which is far better then simple black and white image.

2.6 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:
- **Gray_Level reduction : reduce pixel intensity value I(r, c).**
- **Spatial reduction : reduce the spatial coordinate (r, c).**

- The simplest method of gray-level reduction is **Thresholding.**
- **The Procedure of Thresholding process:**
- We select a **threshold gray _level**
- Set each intensity value above that threshold value equal to "**1**"
- Set each intensity value below the threshold value equal to "**0**".

NOT: **This effectively turns a gray_level image into a binary (two level) image**

Cont.

Application of Image Quantization:

- Its often used as a preprocessing step in the extraction of object features, such as shape, area, or perimeter.
- Also, the 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 determined the number of gray levels available**.

Example:

We want to reduce **8_bit** information (256 gray_level) values down to **5-bit** (32 gray- levels) values.

NOT: 8-bit indicates that we need 8 bits to represent each pixel value

8 bits – 5 bits = 3 bits for each pixel

- This can be done by applying the (AND) logical operation for 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.**
- 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.

Example : perform image quantization of 8-bit (256 gray-level) into 7-bit (128 gray level),

Solution: 8 bits – 7 bits = 1 bit

this can be done by AND (logical operation) each 8-bit value with bit string 11111110 (2^1).

Example : perform Image quantization of 8-bit (256 gray-level) into 6-bit (64 gray_level).

Soluotion: 8 bits –6 bits = 2 bit

- This can be done by ANDing each 8-bit value with bit string 11111100 (2^2).

NOT : 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 methed.

Original 8-bit image, 256 gray levels

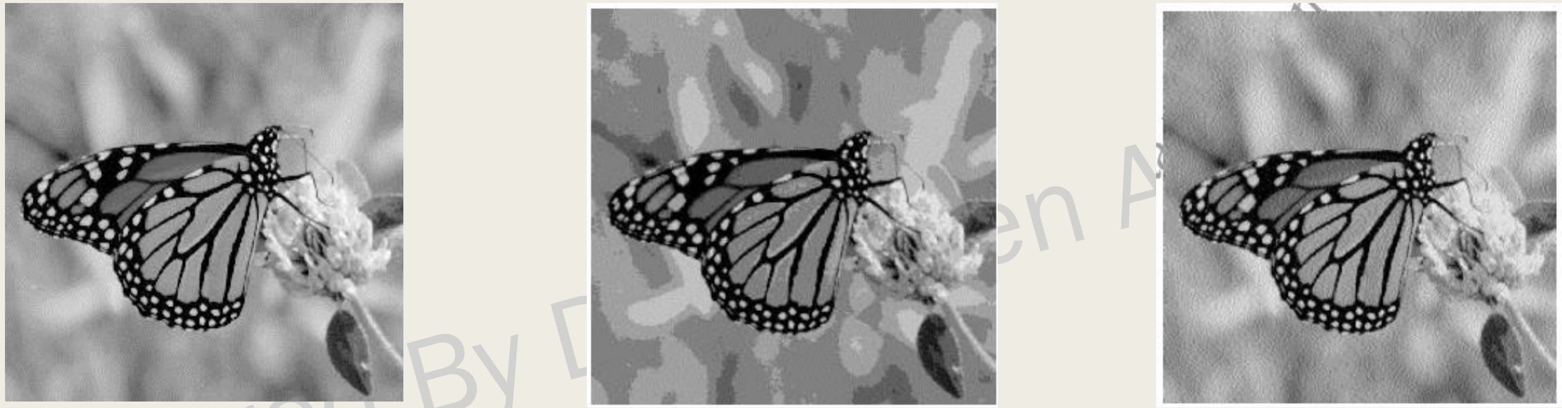
Quantized to 6 bits,64 gray levels

Quantized to 3 bits,
8 gray levels

Quantized to 1 bit ,
2 gray levels

Figure (2-17): False Contouring

The **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 carried out 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 (2-18): IGS quantization

Example: the pixels values of the following (2x2) image are represented by 8-bit integers

I=

123	162
137	15

, **Determine I with a gray – level resolution of 2^k for k=5, k=3**

Solution:

1. **k= 5 ----→ 2^k = 32 (gray-level)**

8 – 5 = 3, (lower three bits)

The mask= 11111000

123 = 0111 1011
Mask= **1111 1000**

0111 1000 =120

162 = 1010 0010
Mask = 11111000

1010 0000=160

137 = 10001001
Mask = 11111000

1000 1000 = 136

15 = 00001111
Mask = 11111000

0000 1000=8

Iq=

120	160
136	8

2. **k= 3 , (H.W)**