SAMPLING AND QUANTIZATION

DIGITAL IMAGE PROCESSING

Dr. Irfan Ali, PhD
Assistant Professor (AI & MMG)

Aror University of Art, Architechture, Design & Heritage, Sukkur

- Digital images are made of pixels.

To convert real-world images into digital form → two steps:

- Sampling
- Quantization.

• What is Sampling?:

- Sampling = Selecting pixels at discrete intervals from an image.
- Controls spatial resolution (detail in the image).
- More samples = better quality (but more data).

- Examples:

Sampling Example :

- High sampling → clear image.
- Low sampling → image looks blocky or blurry

Sampling

• What is Quantization?:

- Quantization = Mapping pixel intensity values to a limited set of levels.
- Controls gray levels (brightness levels).

Example:

- 2 levels → black & white.
- 256 levels → smooth grayscale.

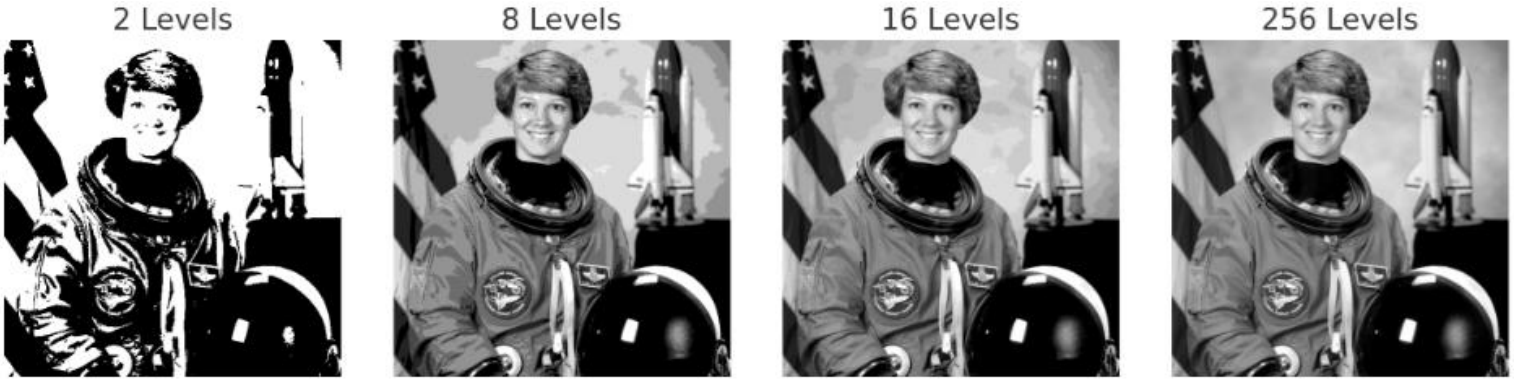
- **What is Quantization?:**

Example

Low quantization → posterized, less detail.

High quantization → smoother shading.

(Show example: same image with 2, 8, 16, 256 levels).



Quantization

Sampling Vs Quantization

Sampling	Quantization
Deals with **pixels (spatial domain)**	Deals with **intensity values**
Controls **resolution**	Controls **gray levels**
More samples → sharper image	More levels → smoother image

- # Applications:
  - Image compression (JPEG).
  - Medical imaging (CT, MRI).
  - Computer vision (face recognition).
  - Multimedia (cameras, scanners)..

Storage: sampling and quantization

Data

Given: 128×128, 5 bits/pixel

Storage in bytes?

Solution

128* 128= 16384
16384* 5= 81920

81920/8= 10240 bytes Ans

Sampling rate: (Nyquist)

Data

Given: Max spatial frequency = 40 cycles/mm?

Sampling rate?

Solution

2* 40= 80 cycles/mm

Quantization Levels from Bits

Data

Given: 6 bits/pixel?

Gray levels?

Solution $2^n = 2^6 = 64$ Grey levels

Sampling factor --- New resolution

Data

Given =2048×2048 down-sampled by factor 4
New resolution?

Solution

2048 /4 ---- 2048/ 4

512 *512 Ans

Reduced Resolution (Downsampling Factor)

Data

Given: 1024×1024 → 256×256

D.S factor?

Solution

1024/ 256= 4
D.S factor is 4 Ans