Chapter 1 : Reminder on Image Processing

1. **Digital Image System Basics**

   - **Digital Image Definition**: An image processed or entirely created by a computer, stored in binary form.
   - **Acquired**: Via analog-to-digital converters in devices like scanners, digital cameras, camcorders, and video capture cards.
   - **Created**: Using software, mouse, graphic tablets, or 3D modeling.
   - **Processed**: Transforming, resizing, color altering, adding/removing elements, applying filters.
   - **Storaged**: On digital media (USB drives, hard drives, CD-ROMs, etc.).

2. Types of Images

Aspect	Vector Images	Bitmap Images
Basic Definition	Created from geometric shapes	Composed of pixels
Image Creation	Defined by mathematical formulas	Defined by color values in each pixel
File Size	Generally smaller, scalable	Larger, fixed size
Scalability	Easily scalable without loss of quality	Loses quality when resized
Complexity	More complex to manipulate	Simpler to manipulate
Best Used For	Logos, illustrations, technical drawings	Realistic images, photographs
Editing	Difficult for detailed image editing	Easier for detailed image editing
Resolution Dependency	Not dependent on resolution	Resolution-dependent
Examples of File Formats	SVG, EPS	JPEG, PNG, BMP
Common Tools	Adobe Illustrator, CorelDRAW ,InDesign, AutoCAD,	Adobe Photoshop, GIMP

3. **Pixel and Image Definition**

   - **Pixel**: The smallest element of a digital image.
   - **Image Definition**: Determined by the number of pixels in width and height (e.g., 320x200 pixels).

4. **Image Resolution**

   - Measured in pixels per inch (PPI or DPI - DotPerInch -). Affects the quality of the image when printed or displayed at different sizes.

5. **Color Encoding**

- Color depth is the number of bits used to represent the color of each pixel.
- Higher color depth allows more colors and more detailed color representation.
- **Bitmap Black & White**: 1 bit per pixel.
- **Bitmap 256 Color**: 8 bits per pixel.
- **True Color**: RGB color model, each color component is 8 bits, totaling 24 bits per pixel (16,777,216 colors).

6. **Image Size**

- The size of a digital image can be calculated by multiplying the total number of pixels by the number of bytes per pixel.
- This calculation is crucial for understanding storage requirements and the impact on loading times in web development.

7. **Image Compression**

- Compression reduces file size for efficient storage and faster transmission.

- **Lossless Compression:**

    - Maintains the original image data (e.g., PNG, GIF, TIFF).
    - Ideal for images requiring frequent editing or images where quality is a priority.
    - Typically results in larger file sizes compared to lossy compression.

- **Lossy Compression:**

    - Reduces file size by permanently removing some image data (e.g., JPEG).
    - Useful for reducing storage and bandwidth requirements, especially for web images.
    - Over-compression can lead to noticeable quality loss, particularly in areas with high detail or sharp contrasts.

8. **Applications of Compression**

- **Lossless compression** is essential for applications where image quality cannot be compromised, such as medical imaging or technical illustrations.
- **Lossy compression** is more suited for web images, where loading speed is crucial, and minor quality reductions are acceptable.

9. **Image Formats**

- **JPEG**

    - **Use:** Best for photos and realistic images.
    - **Compression:** Lossy, can significantly reduce file size but may affect quality.
    - **Transparency:** Not supported.

- **PNG**

    - **Use:** Ideal for web graphics requiring transparency or sharp edges.

- **Compression:** Lossless, preserving original quality.
- **Transparency:** Supported.

- **GIF**

  - **Use:** Suitable for simple animations and limited color images.
  - **Color Palette:** Limited to 256 colors.
  - **Compression:** Lossless but can result in larger files for color-rich images.

- **TIFF**

  - **Use:** Professional photography and publishing.
  - **Compression:** Can be uncompressed or use lossless compression.
  - **Color Depth:** Supports high color depth.

- **BMP**

  - **Use:** Uncompressed format, native to Windows.
  - **File Size:** Large due to lack of compression.
  - **Quality:** High, suitable for detailed editing.

11. **Color Systems**

- **Additive Color Mixing (RGB):** Used in screens where colors are created by adding light. Mixing red, green, and blue light can produce various colors, including white.
- **Subtractive Color Mixing (CMYK):** Used in printing where colors are created by subtracting light. Cyan, magenta, and yellow inks absorb light, and the combination can produce a wide range of colors.
- **HSL (Hue, Saturation, Luminance):** This model is intuitive for human understanding and manipulation of color. Hue is the type of color, Saturation is the intensity of the color, and Luminance is the brightness or darkness of the color.