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1. What is image processing?

ANS. Image processing refers to the manipulation and analysis of digital images using various algorithms and techniques. It involves the processing of images to enhance their quality, extract meaningful information, and perform tasks such as image restoration, recognition, segmentation, and feature extraction.

Image processing can be divided into two main categories: analog and digital image processing. Analog image processing involves manipulating physical photographs or film negatives using techniques like cropping, filtering, and retouching. Digital image processing, on the other hand, deals with manipulating digital images using computer algorithms.

In digital image processing, an image is represented as a two-dimensional array of pixels, where each pixel contains information about the color or intensity at a particular location. Image processing techniques can be applied to individual pixels or groups of pixels to achieve desired results.

2. Explain how the captured image stored in digital form?

ANS. When an image is captured and stored in digital form, it undergoes a process called digitization. The following steps outline how this process occurs:

Image Capture: The image is captured using a digital imaging device such as a digital camera or a scanner. The device uses an image sensor (e.g., a charge-coupled device or CMOS sensor) to convert the incoming light into electrical signals.

Sampling: The captured image is divided into a grid of tiny picture elements called pixels. Each pixel represents a small area of the image and contains information about its color or intensity. The image is sampled by measuring the light intensity at discrete points within each pixel.

Quantization: The measured light intensities are then quantized, which means they are assigned numerical values. The quantization process determines the number of bits used to represent each pixel's intensity. For example, grayscale images typically use 8 bits per pixel, allowing for 256 different shades of gray.

Color Representation: If the image is a color image, it needs to represent the color information for each pixel. This is commonly done using the RGB color model, where each pixel is represented by a combination of red, green, and blue color channels. Other color models like CMYK or HSL may also be used depending on the application.

Image File Format: The digitized image data is then typically compressed and stored in a specific file format such as JPEG, PNG, or TIFF. These file formats use various compression techniques to reduce the file size while preserving the essential visual information.

Metadata: Along with the pixel data, additional information known as metadata may also be stored. Metadata includes details about the image such as the capture date, camera settings, GPS coordinates, and any post-processing applied.

Once the image is stored digitally, it can be manipulated, processed, and displayed on various devices such as computers, smartphones, or digital screens. The digital representation allows for easy storage, transmission, and manipulation of images compared to traditional

analog formats like prints or negatives.

3. In an image, if one pixel is present at the location P(x-1, y+1), then what are the coordinates of its 8-connected neighborhoods?

ANS. In an image, if one pixel is present at the location P(x-1, y+1), its 8-connected neighborhoods are the pixels that are directly adjacent to it in the horizontal, vertical, and diagonal directions. The coordinates of these neighborhoods are as follows:

P(x, y+1): The pixel directly above P.
P(x+1, y+1): The pixel diagonally up and to the right of P.
P(x+1, y): The pixel to the right of P.
P(x+1, y-1): The pixel diagonally down and to the right of P.
P(x, y-1): The pixel directly below P.
P(x-1, y-1): The pixel diagonally down and to the left of P.
P(x-1, y): The pixel to the left of P.
P(x-1, y+1): The pixel diagonally up and to the left of P.
These eight pixels together form the 8-connected neighborhood of the pixel at location P(x-1, y+1).

4. Explain sampling and quantization with example.

ANS. Sampling and quantization are two fundamental processes in the

digitization of analog signals, including images. Here's an explanation of both processes with examples:

Sampling:

Sampling is the process of converting a continuous analog signal (such as an image) into a discrete digital representation by capturing and recording discrete samples of the signal at regular intervals. In the context of images, this means converting the continuous variations of light intensity into a grid of discrete pixels.

Example: Let's consider a grayscale image. The original analog image consists of a smooth gradient from black to white. To sample this image, we divide it into a grid of pixels and capture the intensity value at each pixel. Suppose we have a 10x10 image. The sampling process involves measuring and recording the intensity value at specific points within each pixel, resulting in a discrete representation of the image.

Quantization:

Quantization is the process of assigning numerical values to the sampled analog signal. It involves mapping the continuous range of signal values to a finite set of discrete values. In the case of images, quantization is applied to represent the intensity values of pixels with a finite number of bits.

Example: Let's consider an 8-bit grayscale image. The quantization process divides the range of intensity values, which typically spans from 0 (black) to 255 (white), into a finite set of levels. In this case, there are 2^8 = 256 possible intensity levels. Each pixel in the image is then assigned one of these levels based on its intensity value. For example, an intensity value of 127 might be assigned to a pixel, indicating a medium gray shade.

The combination of sampling and quantization allows the continuous analog image to be converted into a digital representation that can be stored, processed, and transmitted using discrete values. These processes are essential in the field of digital image processing and enable various image manipulation techniques and algorithms to be applied to the digital image data.