1

a. Define Histogram Matching and Histogram Equalization. State the limitations to Histogram Equalization?

Histogram matching is a method for changing an image's intensity distribution to match a reference histogram. causing the image to change in the way that is wanted.

By rearranging the intensity values so that the histogram is roughly consistent, a technique called histogram equalization seeks to improve the contrast of an image.

The contrast may be improved via histogram equalization. It might potentially exacerbate image noise. In order to address this problem, adaptive histogram equalization techniques have been created that take into account smaller areas of the image.

b. Write working principle on Histogram Matching and its applications commonly used?

For both the source and reference histograms, cumulative distribution functions (CDFs) are computed throughout the process of histogram matching. Following that, the CDFs are used to map the pixel intensities in the source image to matching intensities in the reference histogram.

Histogram Matching is utilized in many different applications, including computer vision, remote sensing, and medical picture analysis. It can be used to align various photos for better comparison or to standardize image appearance.

c. Perform histogram matching on three-bit image with size n by n and same to the reference image given below:

**Math**

2.

a. Describe the difference between spatial domain filtering and frequency domain filtering and explain the concept of image filtering and its significance in image processing?

By convolving the image with a filter kernel, spatial domain filtering entails directly changing the pixel values in the image. Using methods like the Fourier Transform, frequency domain filtering entails converting the image into the frequency domain. Filtering procedures are applied there, and the outcome is subsequently transformed back

into the spatial domain. Frequency domain filtering accentuates patterns based on their frequency properties and is frequently used for tasks like noise removal.

To conduct operations like blurring, sharpening, edge detection, and noise reduction, an image is convolved with a filter Kamel (also known as a convolution kernel or mask). Filtering is important because it improves picture features, reduces noise, and extracts pertinent data for a variety of applications, including computer vision, image analysis, and feature extraction.

b. State the purpose of a convolution kernel in image filtering, and its influence the filtering process?

The operation that has to be done during filtering is specified by a convolution kernel. A tiny matrix is slid over the picture. and at every place. The appropriate image region and the kernel are multiplied element-by-element. The new value at that location in the filtered image is determined by the sum of these multiplications. By altering the weights in the matrix, different kernels highlight particular traits (such blurring or sharpening, for example).

c. State steps for butter-worth low pass filter, and hence filtered image of an image given below with Do=0.5:

**Math**

3.

a. Differentiate between edge detection and image sharpening filters in terms of their kernel weights and intended outcomes?

By highlighting abrupt variations in pixel intensity, edge detection filters like the Sobel or Prewitt operators are intended to draw attention to edges or boundaries in an image. To collect gradient information, their kernels are weighted positively and negatively. On the other side, picture sharpening filters emphasize high-frequency components to improve image details. They make use of kernels that increase pixel contrast. Image sharpening enhances fine details while edge detection strengthens edges.

b. Describe the challenges faced when applying edge detection techniques to noisy images and how these challenges can be mitigated?

Unreliable edge detection results can originate from noise, which can produce fictitious edges. Noise reduction methods include edge detection followed by Gaussian blurring.

Additionally, edge maps can be improved by applying post-processing techniques like thresholding and non-maximum suppression to eliminate weak or erroneous edges brought on by noise.

c. Describe Canny edge detection algorithm, and state the reasons why it considered a multi-stage process?

The multi-stage Canny edge detection technique seeks to find edges while suppressing noise. It entails actions like hysteresis thresholding to distinguish between strong and weak edges, non-maximum suppression to thin edges, and gaussian blurring to reduce noise. This multi-stage process aids in producing precise and well-defined edges.

4.

a. Define image segmentation, and its important in image processing. State the main types of image segmentation techniques?

Using criteria like color, intensity, texture, or other visual features, image segmentation is a fundamental technique in computer vision and image analysis that involves breaking an image into meaningful and distinct segments or regions. To divide an image into sections that correspond to particular items or areas of interest is the purpose of image segmentation. facilitating the analysis and comprehension of the image's content.

Image segmentation is important for image analysis because it may give the content of a picture a structured representation. The importance of picture segmentation can be seen in the following ways:

1. picture segmentation facilitates the identification and localization of specific objects or regions within a picture. This is necessary for a number of applications, including medical image analysis, where the diagnosis of different organs or tissues depends on segmenting them in medical scans.
2. Object recognition: By dividing up a picture into sections, object recognition algorithms can concentrate on examining unique items one at a time. This enables recognition algorithms to focus on characteristics specific to each object, enhancing their accuracy.
3. Semantic comprehension: Segmentation helps to increase the semantic comprehension of an image. by dividing an image into informative parts. Computers are better able to understand the connections between various visual aspects.
4. Segmentation enables focused editing and manipulation of particular areas within an image. This is known as image editing and image manipulation. This is especially helpful in programs like backdrop replacement and image editing.

5. Scene comprehension: Segmenting an image aid in detecting various elements of a scene, such as foreground objects, in computer vision tasks like scene comprehension. auxiliary components. and their connections with one another.
6. Image segmentation helps with object tracking by giving a segmented item a constant identity over several frames, making it simpler to follow its movement and changes.
7. Robots and autonomous systems must comprehend their surroundings in order to function properly. Robots can explore their environment, identify barriers, and interact with things with the aid of segmentation.
8. Segmentation is the foundation for producing labeled datasets, which are necessary for training machine learning and deep learning models. It offers factual data for supervised learning applications.

By simplifying the visual data, segmentation significantly improves object recognition and other computer vision tasks. as opposed to handling the complete image as a whole. Algorithms can concentrate on studying more narrowly defined regions. This makes it possible to extract more accurate and pertinent features. improving the accuracy of tasks including scene interpretation, object detection, tracking, and object classification. Segmentation bridges the gap between raw pixel data and higher-level understanding by dividing the image into meaningful portions, opening the door for more complex and sophisticated computer vision applications.

b. Explain 'convolutional neural networks (CNNs) be used for image segmentation. Write some challenges in image segmentation?

CNNs are capable of object segmentation through supervised learning. On labeled datasets, which pair input images with corresponding segmentation masks, they are trained. The network learns to recognize characteristics and patterns that set apart various objects and locations. allowing precise segmentation.

c. Define semantic segmentation. and differentiate it from instance segmentation. In medical imaging. how can image segmentation be applied?

Each pixel in an image is divided into specified categories (such as object classes) by semantic segmentation. All pixels belonging to the same class are given the same label. On the other hand, instance segmentation not only assigns pixels to their appropriate classes but also makes a distinction between various instances of a single class. giving each individual object instance a distinctive label.