### **PYQ’s**

1. **Discuss the applications of digital image processing in various fields.**

* Improvement of pictorial information for human perception
* Image processing for automated machine applications (Quality control in assembly automation)
* Efficient Storage and transmission (reducing size of image)
* **Medical Technology** - In the medical field, Image Processing is used for various tasks like PET scan, X-Ray Imaging, Medical CT, UV imaging, Cancer Cell Image processing,
* **Computer / Machine Vision** - Self Driving cars, Drones etc. CV helps in obstacle detection, path recognition, and understanding the environment.
* **Geographic Information Systems(GIS)** - Digital image processing techniques are used extensively to manipulate satellite imagery
* **Industrial Inspection -** Making machines do the job of inspecting products as per standard by accepting or degrading.
* **Printed Circuit Board (PCB) inspection** - Machine inspection is used to determine that

all components are present and that all solder joints are acceptable

1. Explain 4-connectivity, 8- connectivity and m-connectivity between the pixels. Draw a suitable diagram to demonstrate the concept.
2. Explain thresholding function using suitable diagrams.
3. What is Bit- Plane Slicing? What is the advantage of applying Bit-Plane Slicing on an image?

### **Unit 1**

| Unit-1- topic wise | | | |
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|  | **Introduction:**   1. Explain the term "digital image." How is it represented in a computer? 2. **Define image processing and explain its primary objectives.**   Image processing refers to the technique of manipulating or analyzing digital images through various algorithms and operations to improve or extract useful information from them. It involves the use of computational methods to process an image and make it more suitable for various applications, such as image enhancement, recognition, or compression.   1. **Image Enhancement**: Improve image quality by adjusting aspects like brightness, contrast, and sharpness, making it clearer or more visually appealing. 2. **Image Restoration**: Restore a degraded image by reducing noise or correcting blurring to bring it closer to its original state. 3. **Image Compression**: Reduce image file size for easier storage and transmission without significant loss of quality. 4. **Feature Extraction**: Identify important patterns or structures (e.g., edges or textures) from an image for further analysis. 5. **Image Segmentation**: Divide an image into distinct regions or segments based on specific characteristics, simplifying analysis. 6. **Image Recognition**: Identify objects or patterns in an image, such as faces, shapes, or scenes. 7. **Image Analysis**: Extract meaningful data or perform measurements (e.g., counting objects, determining areas) from an image. 8. **Visual Interpretation**: Enable systems to understand and interpret an image’s content for decision-making, such as recognizing scenes or diagnosing conditions. 9. **List the key steps involved in the digital image processing pipeline.**   Digital Image Processing Involves following basic Tasks-  **1. Image Acquisition-**  Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves pre-processing, such as scaling etc.  **2. Image Enhancement**  Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. Such as, changing brightness & contrast etc.  **3. Image Restoration**  Unlike enhancement, which is subjective, image restoration is objective. Restoration techniques tend to be based on mathematical or probabilistic models of image degradation.  **4. Color Image Processing-**  It deals with pseudocolor and full color image processing color models are applicable to digital image processing.  **5. WAVELETS AND MULTI-RESOLUTION PROCESSING–**  It is the foundation of representing images in various degrees of resolution. It is used for image data compression  **6. Compression-**  Compression deals with techniques for reducing the storage required to save an image or the bandwidth to transmit it.  **7. Morphological Processing-**  Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape  **8. Segmentation-**  Segmentation procedures partition an image into its constituent parts or objects.  **9. Representation and Description**  Representation and description almost always follow the output of a segmentation stage, which usually is raw pixel data, constituting either the boundary of a region or all the points in the region itself.  **10. Object Detection and Recognition-**  It is a process that assigns a label to an object based on its descriptor.  **11. Knowledge Base -**  Knowledge may be as simple as detailing regions of an image where the information of interest is known to be located, thus limiting the search that has to be conducted in seeking that information.   1. What are the challenges commonly faced in image processing? | |
|  | **Applications of Image Processing:**   1. Name and briefly describe at least three application areas of image processing. 2. How is image processing applied in medical imaging? Provide examples. 3. Discuss the role of image processing in satellite and remote sensing applications. 4. What are the applications of image processing in the field of biometrics? 5. Explain how image processing is used in autonomous vehicles. | |
|  | **Sampling and Quantization:**   1. **Define sampling and quantization in the context of image processing.**  * **Sampling** refers to the process of taking a digital image and breaking it down into smaller, manageable parts. * Think of it as taking a big picture and cutting it into little squares (or pixels). Each pixel represents a small piece of the image. * The more samples you take (the more pixels you have), the higher the image resolution and the more detail you can capture. * **Quantization** is the process of taking the color values of each pixel and rounding them to the nearest value that can be represented in a digital format. * In simple terms, it’s like taking a wide range of colors or brightness levels and reducing them to a smaller, more manageable set of colors or levels. * This is necessary because computers can only handle a limited number of color values. * **Sampling** is how we break the image into smaller parts (pixels). * **Quantization** is how we decide what color or brightness level each pixel should have based on the data we collected.   The sampling rate determines the spatial resolution of the digitized image, while the quantization level determines the number of grey levels in the digitized image.     1. What is bit depth, and how does it influence the quality of an image? | |
|  | Relationship Between Pixels   1. Define the concept of pixel connectivity. What are 4-adjacency and 8-adjacency ? 2. What is adjacency in terms of pixel relationships? Provide examples. 3. Explain the term "neighborhood" of a pixel. How is it useful in image processing? 4. Discuss the importance of connectivity in image segmentation and object recognition. 5. What are the potential ambiguities in 8-connectivity? How can they be resolved? | |
|  | **Explain the following terms-**   1. **Decimation** 2. **Interpolation**   **Scaling image down**   * The process of reducing the raster dimensions is called **decimation**, this can be done by averaging the values of source pixels contributing to each output pixel. * Image compression * Limited bandwidth image transmission * Protection of copyrighted material- show a low-resolution image of a * product(movie)   **Scaling image up**   * When we increase the image size we actually want to create sample points between the original sample points in the original raster, this is done by **interpolation** the values in the sample grid, effectively guessing the values of the unknown pixels. * Image resizing -- for enlarging an image or part of an image. * Image restoration after compression | |
|  | Distance Measures   1. What is Euclidean distance, and how is it used in image processing? 2. Compare and contrast city-block distance and chessboard distance. 3. Explain the importance of distance measures in image segmentation. 4. Provide a practical example where distance measures are used in image processing. | |
|  | Convolution and Correlation   1. Define convolution in image processing. How is it different from correlation?   **Correlation**   * Correlation is a technique used to compare an image with a filter (also called a kernel or mask). It involves sliding the filter over the image and calculating how well the filter matches the image at each position. * At each position, the filter is multiplied element-wise with the image pixels underneath. The results are summed up to get a single output pixel value. This is repeated across the whole image. * Often used in template matching, feature detection, or identifying patterns in an image.   **Convolution**   * Convolution is a similar operation but differs from correlation in how the filter is applied. It’s widely used in various image processing tasks like blurring, sharpening, edge detection, etc. * Just like correlation, the filter slides over the image. However, in convolution, the filter is flipped both horizontally and vertically (turned 180 degree) before being applied to the image. * Convolution is commonly used in operations like blurring, sharpening, and edge detection in image processing. | |
| 14 | **Explain the concept of Spatial correlation and spatial Convolution using the 1-D function.**  **1-D function – 00010000**  **W - 12328** |  |
| 15 | **Find the 2D convolution of the given matrices. (Discard padded position so that final answer will be 3X3 matrix)** |  |
| 16 | Explain the concept of Spatial correlation and spatial Convolution using 2-D function.   | 2-D function   | 0 | 0 | 0 | 0 | 0 | | --- | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | | w-window   | 1 | 2 | 3 | | --- | --- | --- | | 4 | 5 | 6 | | 7 | 8 | 9 | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |

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#### **MCQ**

1. **What does the term "digital image" refer to?**

a) A continuous-tone image

b) A collection of pixels arranged in a matrix form

c) A 3D representation of an object

d) A physical photograph

**Answer: b)** A collection of pixels arranged in a matrix form

1. **Which of the following is a typical step in digital image processing?**

a) Image acquisition  
b) Image enhancement  
c) Image segmentation  
d) All of the above

**Answer: d)**

1. **What is a pixel?**

a) The smallest unit of a digital image  
b) A group of colors in an image  
c) A type of filter used in image processing  
d) The brightness of an image

**Answer: a)**

1. **What is the role of a histogram in image processing?**

a) To count the number of objects in an image  
b) To represent the distribution of intensity levels in an image  
c) To detect edges in an image  
d) To enhance the image clarity

**Answer: b)**

1. **What is the purpose of image segmentation?**

a) To reduce image size  
b) To divide an image into meaningful regionsc) To enhance the brightness of an image  
d) To calculate the histogram

**Answer: b)**

1. **In which application is image processing NOT commonly used?**

a) Medical imaging  
b) Satellite imaging  
c) Word processingd) Facial recognition

**Answer: c)**

1. **What is the primary difference between image enhancement and image restoration?**

a) Enhancement focuses on visual appeal, while restoration corrects degradation  
b) Enhancement is automatic, while restoration is manual  
c) Enhancement is for 2D images, while restoration is for 3D images  
d) Enhancement involves filters, while restoration involves segmentation

**Answer: a)**

1. **In a 4-connected neighborhood, how many neighboring pixels are considered for a given pixel?**

a) 4  
b) 8  
c) 6  
d) 3

**Answer: a)**

1. **What is the minimum distance between two pixels called?**

a) Euclidean distance  
b) City-block distance  
c) Chessboard distance  
d) Pixel intensity

**Answer: a)**

1. **When both 4-connectivity and diagonal connectivity are combined, it forms:**

a) 2-connectivity  
b) 6-connectivity  
c) 8-connectivity  
d) Hybrid connectivity

**Answer: c)**

1. **What is the main issue with 8-connectivity in image segmentation?**

a) It increases processing time  
b) It may lead to diagonal pixel ambiguity  
c) It reduces image resolution  
d) It cannot handle grayscale images

**Answer: b)**

1. **How does correlation differ from convolution in terms of kernel orientation?**

a) The kernel is flipped in correlation, but not in convolution  
b) The kernel is flipped in convolution, but not in correlation  
c) Both operations flip the kernel  
d) Neither operation flips the kernel

**Answer: b)**

1. **Which term refers to adding extra rows and columns of zeros around an image before convolution?**

a) Normalization  
b) Padding  
c) Correlation  
d) Striding

**Answer: b)**

1. **In image processing, what does the kernel (or filter) represent?**

a) The input image  
b) The output image  
c) A small matrix used to perform transformations  
d) The pixel intensity histogram

**Answer: c)**

1. **What is interpolation in image processing?**

a) Reducing the size of an image  
b) Increasing the resolution of an image  
c) Compressing an image  
d) Applying a filter to an image

**Answer: b)** Increasing the resolution of an image

1. **What is decimation in image processing?**

a) Reducing the size of an image by downsampling  
b) Upscaling the image resolution  
c) Converting a color image to grayscale  
d) Enhancing the sharpness of an image

**Answer: a)**

1. **What is the key purpose of decimation in image processing?**

a) To smoothen an image  
b) To reduce the amount of data for storage or transmission  
c) To increase the dynamic range of an image  
d) To enhance the contrast of an image

**Answer: b)**

1. **What is sampling in the context of image processing?**

a) Converting an analog signal into a digital signal  
b) Selecting specific points or pixels from a continuous image  
c) Reducing the number of colors in an image  
d) Enhancing the image resolution

**Answer: b)**

1. **What does quantization in image processing refer to?**

a) Mapping continuous intensity values to discrete levels  
b) Subsampling the image resolution  
c) Increasing the number of samples in an image  
d) Interpolating pixel values

**Answer: a)**

1. **How many intensity levels are possible for a pixel in an image with an 8-bit quantization?**

a) 128  
b) 255  
c) 256  
d) 1024

**Answer: c)**

1. **What does the term "bit depth" refer to in quantization?**

a) The number of pixels in an image  
b) The number of intensity levels assigned to each pixel  
c) The size of the image in bytes  
d) The spatial frequency of an image

**Answer: b)**

### **Unit 2**

|  | Explain the following intensity transformations using suitable diagrams.   * 1. Gamma Transformations   2. Contrast Stretching | |
| --- | --- | --- |
| 2. | Explain the following intensity transformations using suitable diagrams.   * + - * 1. Contrast Stretching         2. Thresholding function | |
| 3. | What is a histogram? Explain the process of histogram equalization using an example. | |
| 4. | Explain the following intensity transformations using suitable diagrams.  Log and Inverse Log Transformation  Power Law transformation | |
| 5. | Give an example with an explanation where each of the following changes to gamma would be desirable.   * 1. Set Gamma > 1   2. Set Gamma < 1 | |
| 6. | Explain the two variation of Intensity level slicing using a suitable diagram. | |
| 7. | What is Bit- Plane Slicing? What is the advantage of applying Bit- Plane Slicing on an image? | |
| 8. | Find all the bit planes of the following 4 bit image  0 3 7 8  1 1 2 2  3 14 15 13  4 6 9 11  Convert the values to binary  First, we convert each value in the matrix to its 4-bit binary equivalent:  0 → 0000  3 → 0011  7 → 0111  8 → 1000  1 → 0001  1 → 0001  2 → 0010  2 → 0010  3 → 0011  14 → 1110  15 → 1111  13 → 1101  4 → 0100  6 → 0110  9 → 1001  11 → 1011 | |
| 9. | Perform Histogram equalization for the following image. Plot original and equalized histogram.   | 4 | 4 | 4 | 4 | 4 | | --- | --- | --- | --- | --- | | 3 | 4 | 5 | 4 | 3 | | 3 | 5 | 5 | 5 | 3 | | 3 | 4 | 5 | 4 | 3 | | 4 | 4 | 4 | 4 | 4 |   Sol:   | no-n | 3 | 4 | 5 | | --- | --- | --- | --- | | N | 6 | 14 | 5 | | Pr(n) | 6/25=.24 | 14/25=.56 | 5/25 =.20 | | S(n) | 3\*.24=.72 -> 1 | 3\*.56=1.68 -> 2 | 3\*.20=.6 ->1 | |
| 10. | Perform histogram equalization and draw new equalized histogram for the following image data. |
| 11. | Perform histogram equalization and draw a new equalized histogram for the following image data.   | Grey level | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | No of Pixels | 400 | | 700 | 1350 | 2400 | 3000 | 1500 | 650 | 0 | |
| 12. | Histogram of an image with 8 quantization levels is given below. Perform histogram equalization. Draw original and equalized histogram. |
| 13. | What is low pass filtering? Discuss the image smoothing filters in spatial domain.   * Average * Weighted Average |
|  | What is salt and pepper noise and how does a median filter remove it? |
| 14. | How does Weighted average filter reduce the effect of blurring as compared to average filter.  Apply the below filter to the given image-   | Input Image   | 40 | 40 | 200 | 40 | 40 | | --- | --- | --- | --- | --- | | 40 | 40 | 40 | 40 | 40 | | 40 | 40 | 100 | 40 | 40 | | 40 | 0 | 40 | 40 | 40 | | 40 | 40 | 0 | 40 | 40 | | 40 | 40 | 40 | 40 | 40 | | Kernel   |  | 1 | 2 | 1 | | --- | --- | --- | --- | | 1/16 | 2 | 4 | 2 | |  | 1 | 2 | 1 | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |
| 15. | Discuss and show the effect of order-statistics filters median, mean on the following-   1. Isolated pixels 2. Thin line 3. A step edge 4. A corner |

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#### **MCQ**

1. **What is the primary purpose of intensity transformation in image processing?**

a) To improve the image resolution  
b) To enhance image details by modifying pixel intensities  
c) To reduce the size of the image  
d) To convert an image into grayscale

**Answer: b)**

1. **Which of the following intensity transformations enhances the contrast of an image by stretching the range of pixel values?**

a) Logarithmic transformation  
b) Power-law transformation  
c) Contrast stretching  
d) Histogram equalization

**Answer: c)**

1. **What is the result of applying a logarithmic intensity transformation to an image?**

a) Enhances bright areas of the image  
b) Increases the overall contrast  
c) Brightens dark regions while compressing bright regions  
d) Makes the image grayscale

**Answer: c)**

1. **Which transformation is often used to improve the brightness of an image, especially in low-intensity regions?**

a) Exponential transformation  
b) Logarithmic transformation  
c) Linear transformation  
d) Gamma correction

**Answer: b)**

1. **What is the main advantage of applying contrast stretching to an image?**

a) It can remove noise from the image  
b) It enhances the visibility of features by expanding the range of pixel values  
c) It increases the image resolution  
d) It converts the image into grayscale

**Answer: b)**

1. What is the main objective of histogram equalization in image processing?

a) To reduce the image resolution  
b) To improve the contrast of an image by redistributing pixel intensities  
c) To convert the image to grayscale  
d) To smooth out the image noise

**Answer**: b) To improve the contrast of an image by redistributing pixel intensities

1. Histogram equalization is most effective when applied to images with:

a) Low contrast  
b) High contrast  
c) Already equalized histograms  
d) Noisy backgrounds

**Answer**: a) Low contrast

1. Which of the following is the result of applying histogram equalization to an image?

a) The image is turned into black and white  
b) The pixel intensities are uniformly distributed  
c) The image size is reduced  
d) The image is blurred

**Answer**: b) The pixel intensities are uniformly distributed

1. After applying histogram equalization, the histogram of the output image is:

a) Concentrated around a small range of intensities  
b) Uniformly spread across all possible intensity values  
c) The same as the input histogram  
d) A smooth bell curve

**Answer**: b) Uniformly spread across all possible intensity values

1. What is the significance of the least significant bit (LSB) in bit-plane slicing?

a) It carries the most important information of the image  
b) It carries the least important details and is often used for hiding data  
c) It represents the highest contrast features of an image  
d) It stores the grayscale values of an image

**Answer**: b) It carries the least important details and is often used for hiding data

1. **When performing bit-plane slicing on an 8-bit grayscale image, how many bit planes will be generated?**

a) 1  
b) 4  
c) 8  
d) 16

**Answer: c)**