Image Processing and Computer Vision

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Image Processing and Computer Vision

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TYITModule-V

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme								Total	Credits
			Theory	Lab	Tut	CA			MSA	ESA					
						Lab	Seminar	GD		CP	HA	ESE	CVV		
S1	IT3221	Operating System	2	2	1	40	-	-		20	-	20	20	100	4
S2	IT3203	Image Processing and Computer Vision	2	2	1		20	-		20	20	20	20	100	4
S3	IT3209	Software Design and Methodologies	2	2	1	-	-	20		20	20	20	20	100	4
S4	IT3218	Artificial Intelligence	2	2	1	40	-	-		20	-	20	20	100	4
S5	IT3212	Engineering Design & Innovation – V	-	2	-	-	-	-	30			70	-	100	6
S6	IT3222	Design Thinking- V	-	-	1	-	-	-	-			-	-		1
Total															23

Course Prerequisites & Course Objectives

- **Course Prerequisites:** Knowledge of Different types of Signals, Linear Algebra, Probability and Statistics.
- **Course Objectives:**

1. To learn Image Processing fundamentals.
2. To study Image preprocessing methods.
3. To understand image lossless and lossy compression techniques.
4. To introduce the major ideas, methods, and techniques of computer vision and pattern recognition.
5. To acquaint with Image segmentation and shape representation.
6. To explore object recognition and its application

Contents

- Signal Processing
- Types of Image Processing

1. Analog Image Processing
2. Digital Image Processing

- What is an Image?
- Types of an image
- What is Image Processing?
- Overlapping fields with Image Processing
- Steps in Image Processing
- Components of Image Processing System
- Application Areas

Signal Processing

- Signal processing is a discipline in electrical engineering and in mathematics that deals with analysis and processing of analog and digital signals , and deals with storing , filtering , and other operations on signals.
- These signals include transmission signals , sound or voice signals , image signals , and other signals .
- Out of all these signals, the field that deals with the type of signals for which the input is an image and the output is also an image is done in image processing. As it name suggests, it deals with the processing on images.
- It can be further divided into analog image processing and digital image processing.

Types of Image Processing

- **Analog Image Processing**

1. Analog image processing is done on analog signals. It includes processing on two dimensional analog signals.
2. In this type of processing, the images are manipulated by electrical means by varying the electrical signal. The common example include is the television image.
3. Digital image processing has dominated over analog image processing with the passage of time due its wider range of applications.

- **Digital Image Processing**

1. The digital image processing deals with developing a digital system that performs operations on an digital image.

Analog vs. Digital Image

Analog Image Processing	Digital Image Processing
The analog image processing is applied on analog signals and it processes only two-dimensional signals.	The digital image processing is applied to digital signals that work on analyzing and manipulating the images.
Analog signal is time-varying signals so the images formed under analog image processing get varied.	It improves the digital quality of the image and intensity distribution is perfect in it.
Analog image processing is a slower and costlier process.	Digital image processing is a cheaper and fast image storage and retrieval process.
Analog signal is a real-world but not good quality of images.	It uses good image compression techniques that reduce the amount of data required and produce good quality of images
It is generally continuous and not broken into tiny components.	It uses an image segmentation technique which is used to detect discontinuity which occurs due to a broken connection path.

What is an Image?

- An image is nothing more than a two dimensional signal.
- It is defined by the mathematical function f(x,y) where x and y are the two co-ordinates horizontally and vertically.
- The value of f(x,y) at any point gives the pixel value at that point of an image.

- The above figure is an example of digital image that you are now viewing on your computer screen.
- But actually , this image is nothing but a two dimensional array of numbers ranging between 0 and 255.

What is an Image?

128	30	123
232	123	321
123	77	89
80	255	255

- Each number represents the value of the function f(x,y) at any point. In this case the value 128 , 230 ,123 each represents an individual pixel value.
- The dimensions of the picture is actually the dimensions of this two dimensional array.

Types of an Image

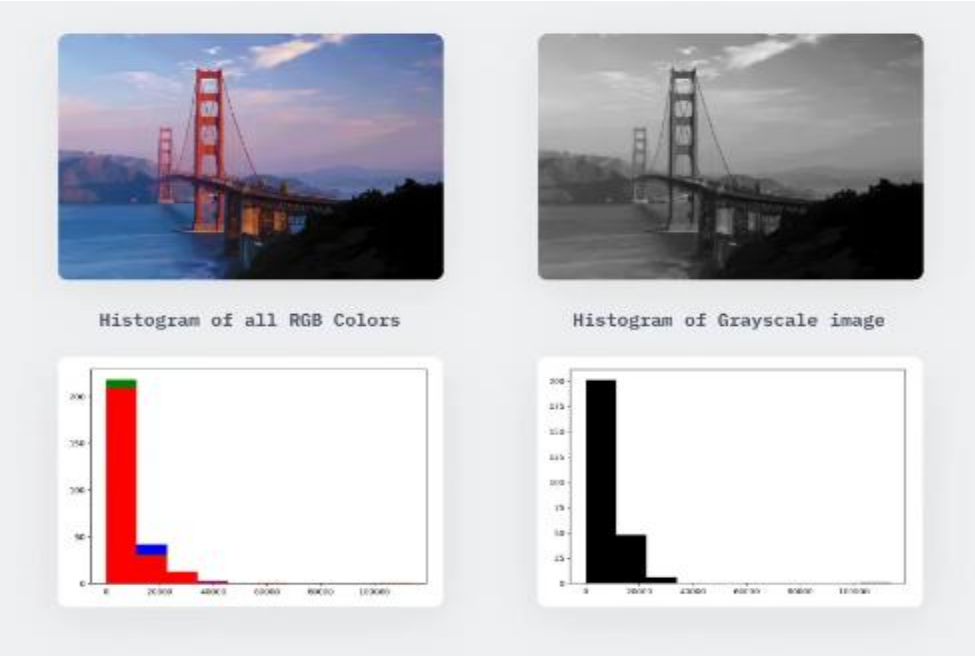
1. Binary Image

Images that have only two unique values of pixel intensity- 0 (representing black) and 1 (representing white) are called binary images. Such images are generally used to highlight a discriminating portion of a colored image. For example, it is commonly used for image segmentation, as shown below.

Types of an Image

2. Grayscale Image

- Grayscale or 8-bit images are composed of 256 unique colors, where a pixel intensity of 0 represents the black color and pixel intensity of 255 represents the white color. All the other 254 values in between are the different shades of gray.
- The shape of the histogram remains the same for the RGB and grayscale images.



Types of an Image

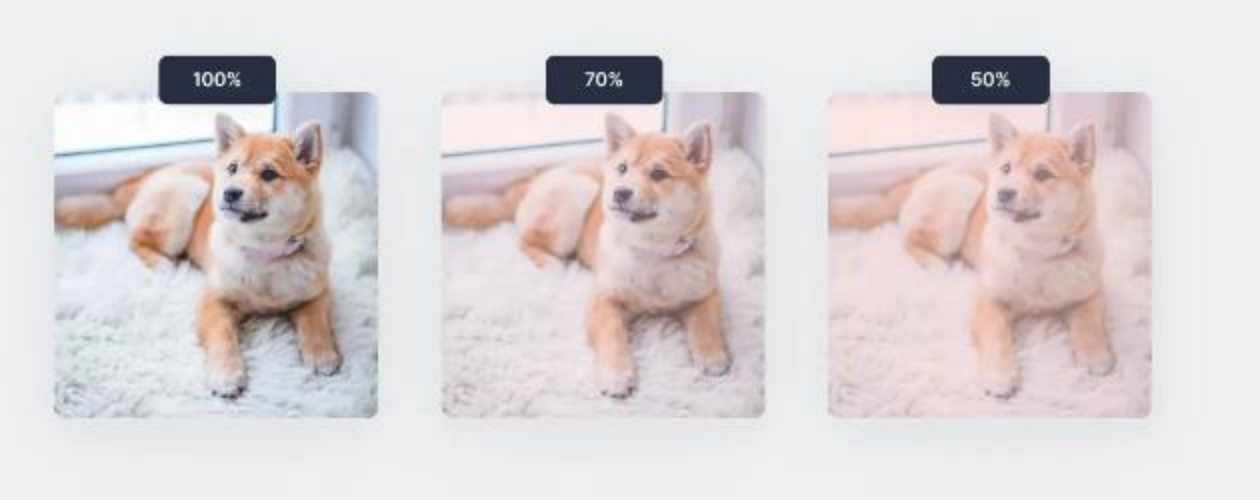
3. RGB Color Image

- The images we are used to in the modern world are RGB or colored images which are 16-bit matrices to computers. That is, **256 X 256 X 256 = 16777216, approximately 16 million** different colors are possible for each pixel. “RGB” represents the Red, Green, and Blue “channels” of an image.
- Thus, a pixel in an RGB image will be of color black when the pixel value is (0, 0, 0) and white when it is (255, 255, 255). Any combination of numbers in between gives rise to all the different colors existing in nature. For example, (255, 0, 0) is the color red (since only the red channel is activated for this pixel). Similarly, (0, 255, 0) is green and (0, 0, 255) is blue.
- The shapes of the histograms for each of the channels are different.

Types of an Image

4. RGBA Image

- RGBA images are colored RGB images with an extra channel known as “alpha” that depicts the opacity of the RGB image. Opacity ranges from a value of 0% to 100% and is essentially a “see-through” property.
- Opacity in physics depicts the amount of light that passes through an object.



What is Image Processing?

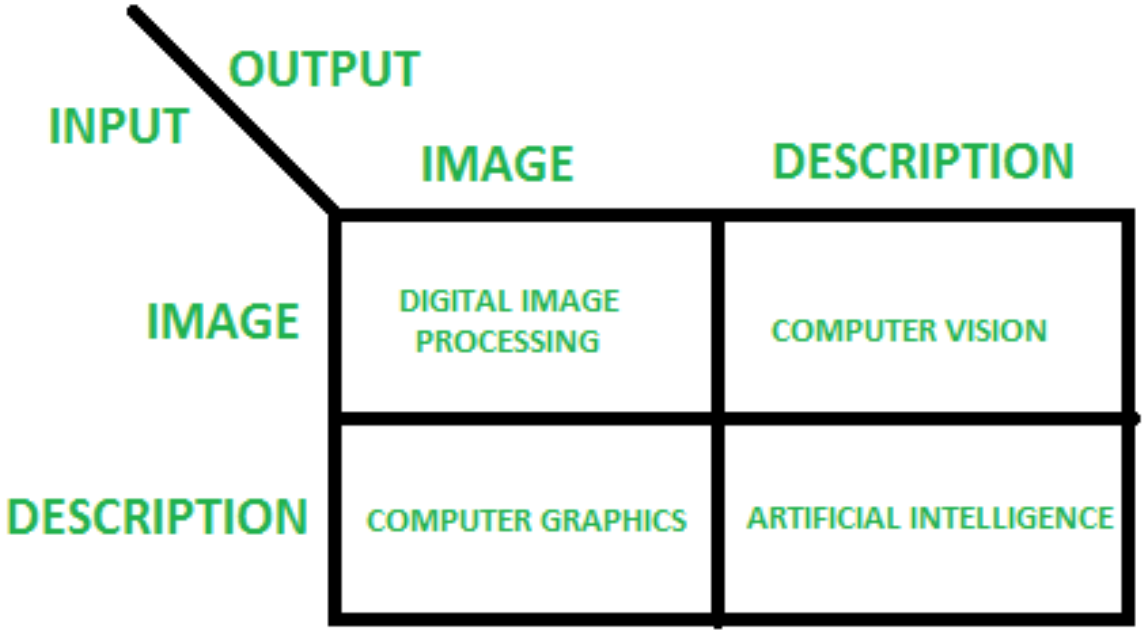
- **Image processing** is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it.

- **Purpose of Image processing**

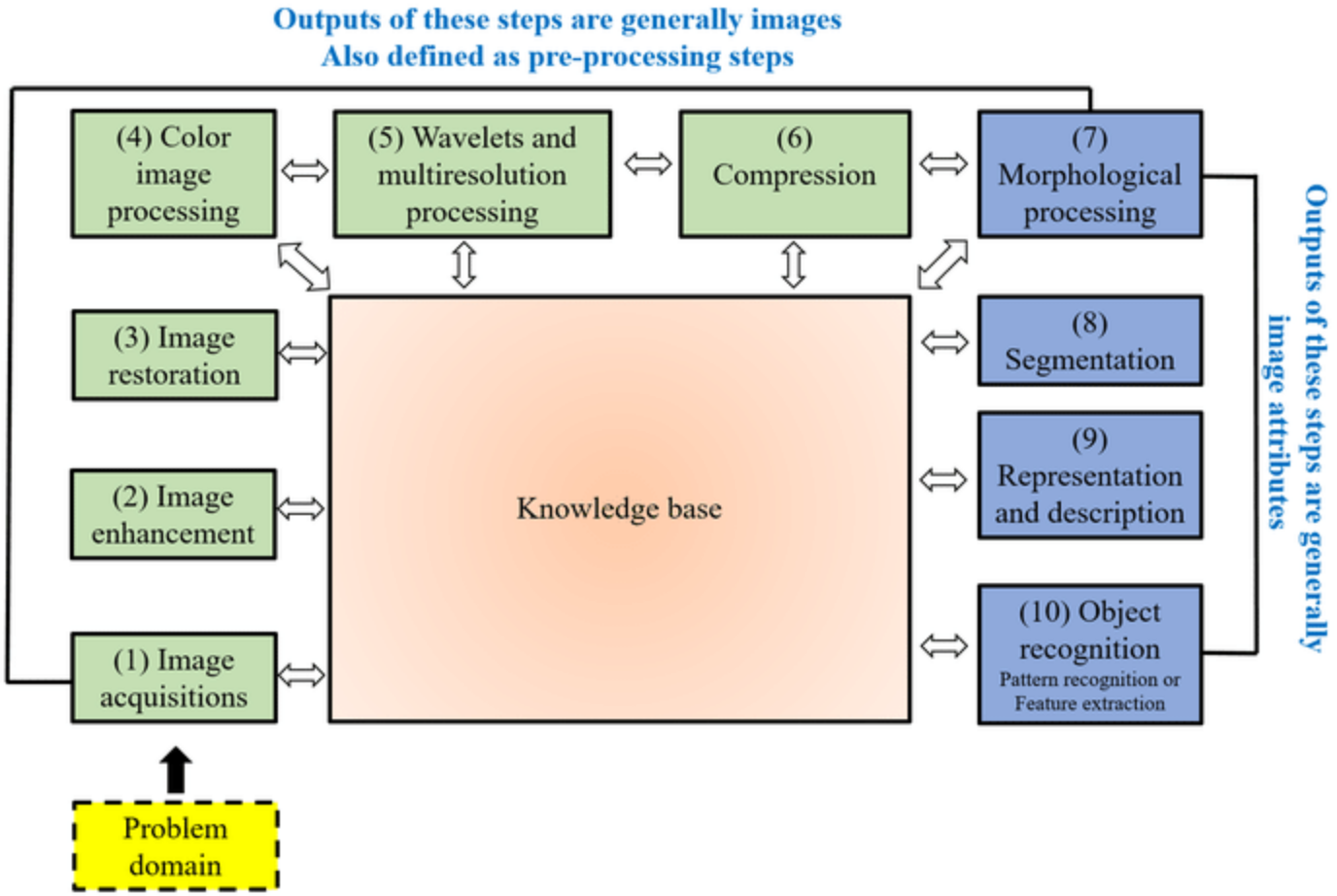
The purpose of image processing is divided into 5 groups. They are:

1. Visualization – Observe the objects that are not visible.
2. Image sharpening and restoration – To create a better image.
3. Image retrieval – Seek for the image of interest.
4. Measurement of pattern – Measures various objects in an image.
5. Image Recognition – Distinguish the objects in an image.

OVERLAPPING FIELDS WITH IMAGE PROCESSING



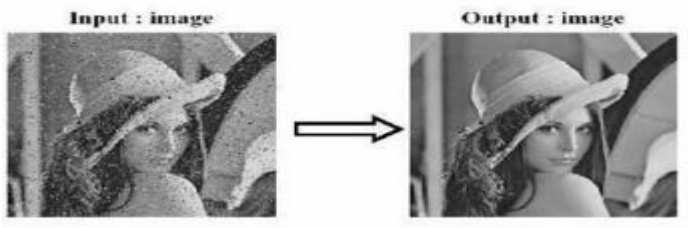
Steps In Image Processing



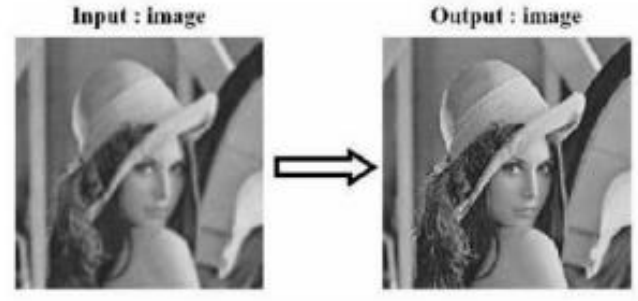
Steps In Image Processing

- **The basic steps involved in digital image processing are:**

- **Image acquisition:** This involves capturing an image using a digital camera or scanner, or importing an existing image into a computer.
- **Image enhancement:** This involves improving the visual quality of an image, such as increasing contrast, reducing noise, and removing artifacts.



- **Image restoration:** This involves removing degradation from an image, such as blurring, noise, and distortion.



Steps In Image Processing

- **Color image processing:** It is an area that is been gaining importance because of the use of digital images over the internet. Color image processing deals with basically color models and their implementation in image processing applications.

- **Wavelets and Multiresolution Processing**: These are the foundation for representing image in various degrees of resolution.

- **Compression:** It deals with techniques reducing the storage required to save an image, or the bandwidth required to transmit it over the network. It has to major approaches a) Lossless Compression b) Lossy Compression

- **Morphological processing:** It deals with tools for extracting image components that are useful in the representation and description of shape and boundary of objects. It is majorly used in automated inspection applications

- **Image segmentation:** This involves dividing an image into regions or segments, each of which corresponds to a specific object or feature in the image.

Steps In Image Processing

- **Image representation and description:** This involves representing an image in a way that can be analyzed and manipulated by a computer, and describing the features of an image in a compact and meaningful way.

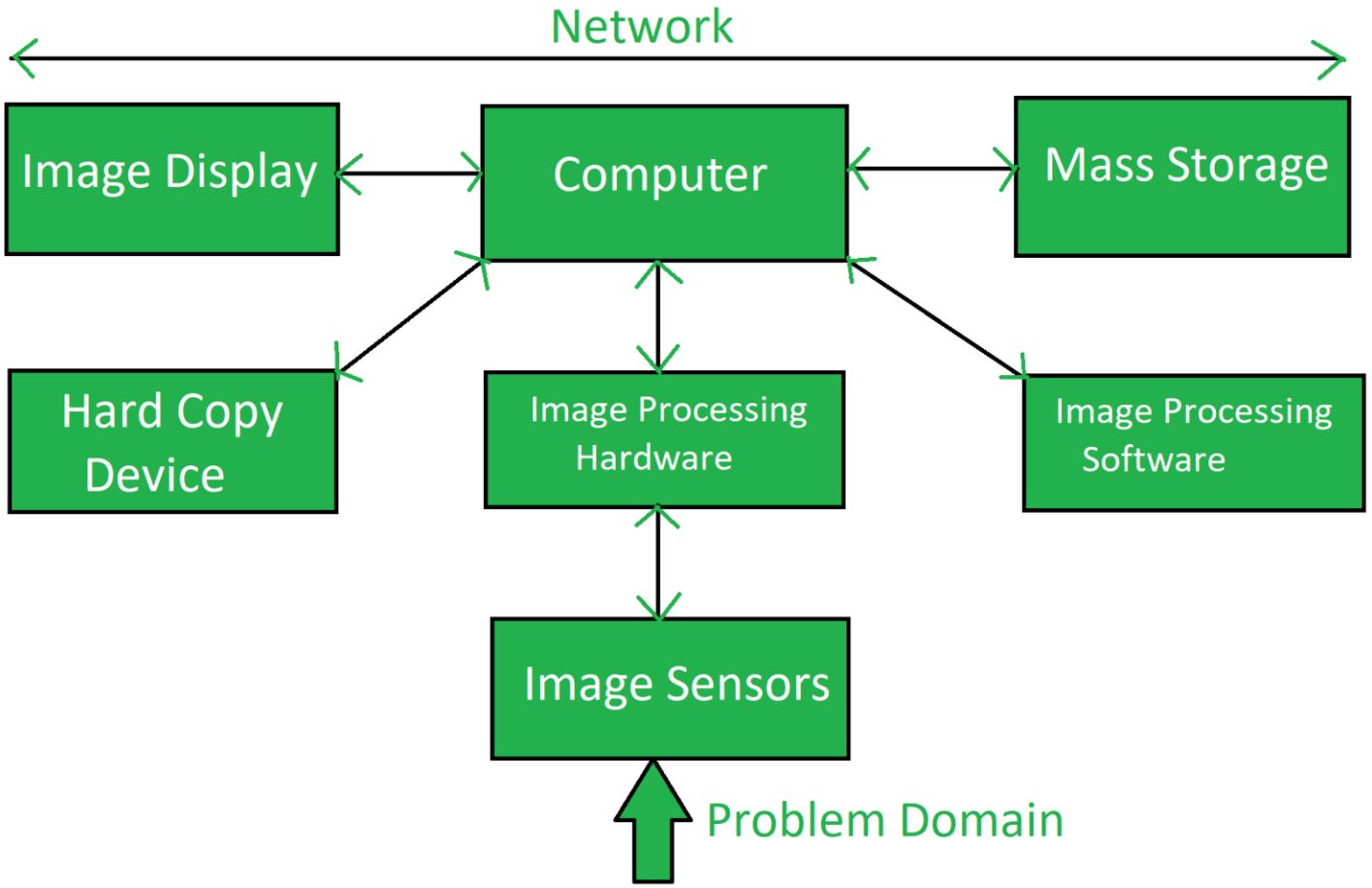
- **Recognition:** It is the process that assigns label to an object based on its descriptors. It is the last step of image processing which use artificial intelligence of software.

- **Knowledge base:** Knowledge about a problem domain is coded into an image processing system in the form of a knowledge base.

Steps In Image Processing

- Importing the image with optical scanner or by digital photography.
- Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs.
- Output is the last stage in which result can be altered image or report that is based on image analysis.

Components of Image Processing System



Components of Image Processing System

1) **Sensor :** The initial part of a digital image processing system is the sensor that is responsible for obtaining the image from the environment and digitizing it into a format compatible for processing by a digital computer.

2) **Specialized digital image processing hardware :** Here analog images are converted to a digital format. Furthermore, primitive operations such as Arithmetic Logical Unit are performed on the input. These systems are characterized by fast speeds.

3) **Computer :** A computer is the main processing part of the digital image processing system that performs the computational tasks.

4) **Software :** Software consists of specialized modules to perform the digital image processing tasks. They are usually coded in a binary format into the processor.

5) **Mass storage :** The images that are processed can be of varying sizes. For example, an image can be 1024 by 1024 pixels, and the intensity of each pixel can be 8 bits. Hence, processing many images of such a size demands a lot of memory. Memory can be in the form of short-term storage such as computer memory or frame buffers.

Components of Image Processing System

6) **Image displays :** Image displays commonly used are color monitors whose display is derived from graphic or image cards.

7) **Hardcopy :** Hardcopy formats that are used to display the output of digital image processing system are paper and image projectors.

8) **Networking :** Networking is an important part of today's digital image processing system, and the key considerations are the bandwidth of transmission as the images require a lot of memory.

Application Areas

- Image sharpening and restoration
- Medical field
- Remote sensing
- Transmission and encoding
- Machine/Robot vision
- Color processing
- Pattern recognition
- Video processing
- Microscopic Imaging
- Others