United Group of Institution
Presentation on
"Fundamentals of Digital Imaging"

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Outline of Presentation

- What is Digital?
- What is an Image?
- What is processing?
- Importance of DIP.
- Difference between Analog Images Processing and Digital Image Processing.
- Why do we need DIP?
- How it works?
- Fundamentals of Digital Imaging.
- Components Of Image Processing System.
- Applications of DIP.

What is Digital?

- Digital describes electronic technology that generates, stores, and processes data in terms of two states: positive and non-positive. Positive is expressed or represented by the number 1 and non-positive by the number 0. Thus, data transmitted or stored with digital technology is expressed as a string of 0's and 1's.
- Digital Technology is primarily used with new physical communications media, such as satellite and fiber optic transmission.

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. When x,y, and amplitude values of F are finite, we call it a **digital image**.
- Digital Image is composed of a finite number of elements, each of which elements have a particular value at a particular location.

What is an Processing?

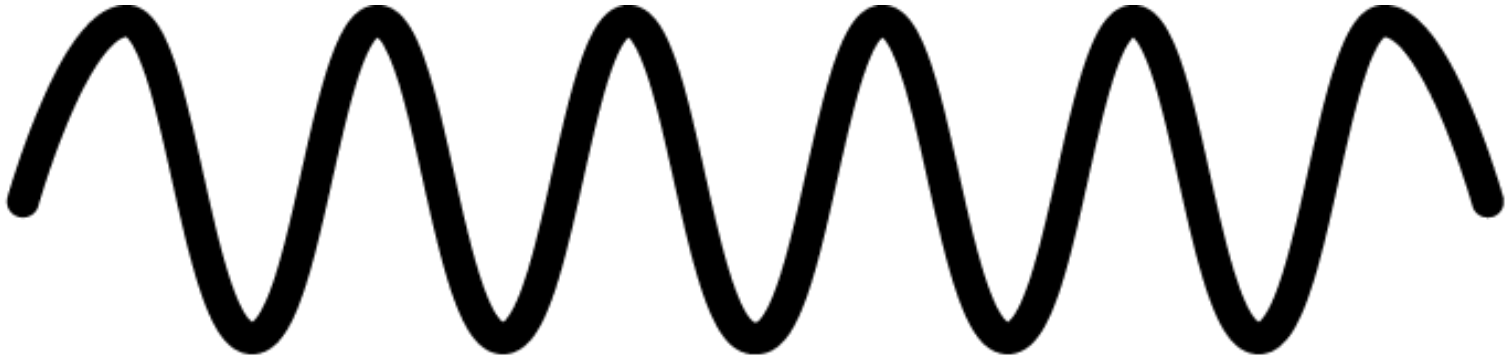
- Processing is a term that describes the process of a software program manipulating or extracting data from a stored file.
- Some of the most common processing devices in a computer include the following: Central processing unit (CPU), Graphics processing unit (GPU), etc.

Importance of DIP

- 1. Every year more then 200 International research and Project Conferences is being organized in world such as
- a)International Conference on Signal and Image Processing (SIGL 2020).
- b)International Journal of Computational Intelligence Research.
- c)Asian Journal of Applied Science and Technology (AJAST).
- C) 100s of Project working with Google,Wipro, Infosys, HCL, HP etc.
- d) Some project like Digital India and Security enhancements by ISRO, DRDO(Image Processing And Computer Vision Algorithms For Defence Research), INDIAN INSTITUTE OF REMOTE SENSING,Ministry of Electronics and Information Technology.

Analog Images Processing:

- The analog image processing is applied on analog signals and it processes only two-dimensional signals.
- Analog image processing is a slower.
- It is generally continuous and not broken into tiny components.
- Examples of analog images are television images, photographs, paintings, and medical images etc.



Analog Signal

Digital Image Processing

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

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- The digital image processing is applied to digital signals that work on analyzing and manipulating the images.
- Digital image processing is a cheaper and fast image storage and retrieval process.
- Examples of digital images are color processing, image recognition, video processing, etc.

Digital Signal

Why do we need DIP?

- To improve the Pictorial information for human interpretation.
  1. Noise Filtering.
  2. Content Enhancement.
  3. Remote Sensing.
- Processing of image data for storage, transmission and representation.

From Students Point of View

- GOVERNMENT OF INDIA (INDIAN INSTITUTE OF REMOTE SENSING)Indian Space Research Organisation(ISRO) working on following project.
  1. Evaluation of Space-borne LIDAR for Terrain Feature Extraction and Mapping.
  2. Mapping Aerosol Optical Depth using IRS-P4 OCM and SeaWiFS Data.
  3. Characterizing Snow Cover in Parts of Himalaya using Active Microwave Remote Sensing.....many more.

GOVERNMENT OF INDIA
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Evaluation of Space-borne LIDAR for Terrain Feature Extraction and Mapping

The major objective of this study is to evaluate the potential of space-borne LIDAR (Light Detection and Ranging) data for extraction and mapping of various terrain features. The data obtained from GLAS (Geoscience Laser Altimeter System) on-board ICESAT (Ice, Cloud and land Elevation Satellite), a space-borne LIDAR launched by NASA in January 2003 for continuous global observations of the Earth, is used in this study. GLAS emits a 1064 nm (for surface topography) laser pulse toward Earth's surface. It has a large foot print of 70 m, successive laser pulses are shot spaced at 172 m along-track. Sahaspur area in the western Dehradun Valley of Uttarakhand State, India, is taken as the test site (Fig. 1).

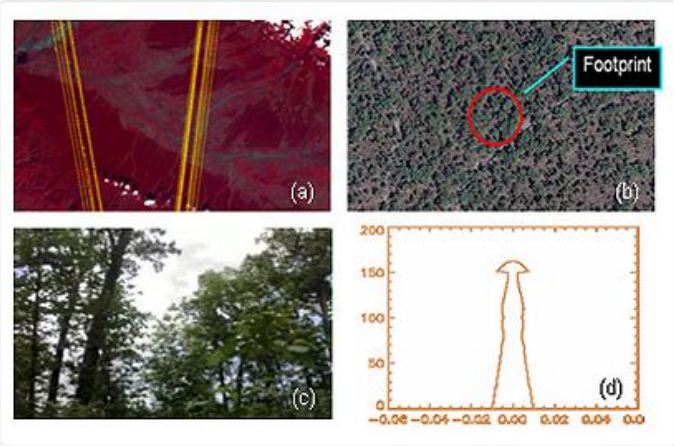
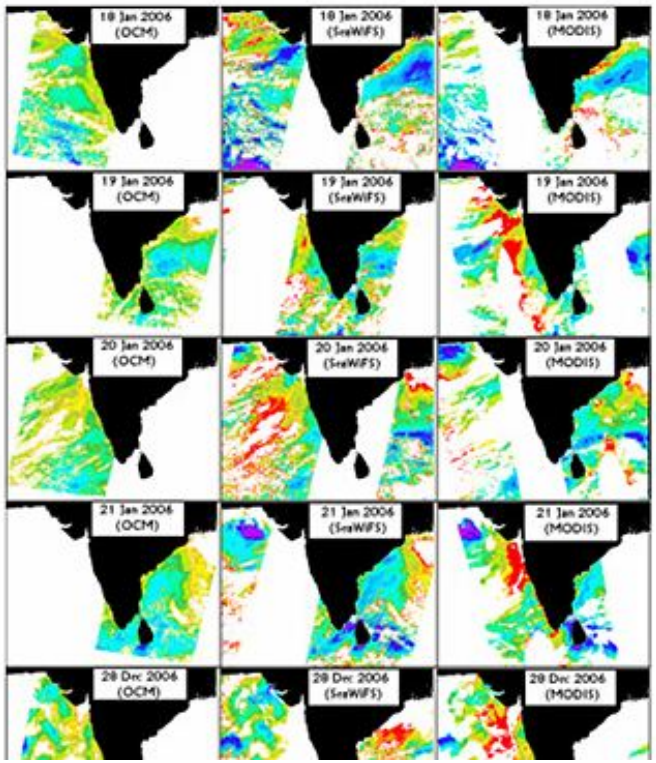


Fig. 1: (a), (b) ICESAT GLAS foot print, (c) ground photo of forest, and (d) tree canopy structure profile from LIDAR waveform data

Mapping Aerosol Optical Depth using IRS-P4 OCM and SeaWiFS Data.

Aerosol optical depth (AOD) derived from SeaWiFS (Sea-viewing Wide Field-of-view Sensor) and MODIS (Moderate Resolution Spectroradiometer) sensors data are routinely used by the scientific community in various climatic studies. An attempt is made to retrieve using IRS-P4 OCM (Ocean Colour Monitor) sensor data, and the results are compared with that obtained from SeaWiFS and MODIS data.

Fig. 3: Aerosol optical depth at 865 nm from SeaWiFS (left), and combined OCM, SeaWiFS (right) data.



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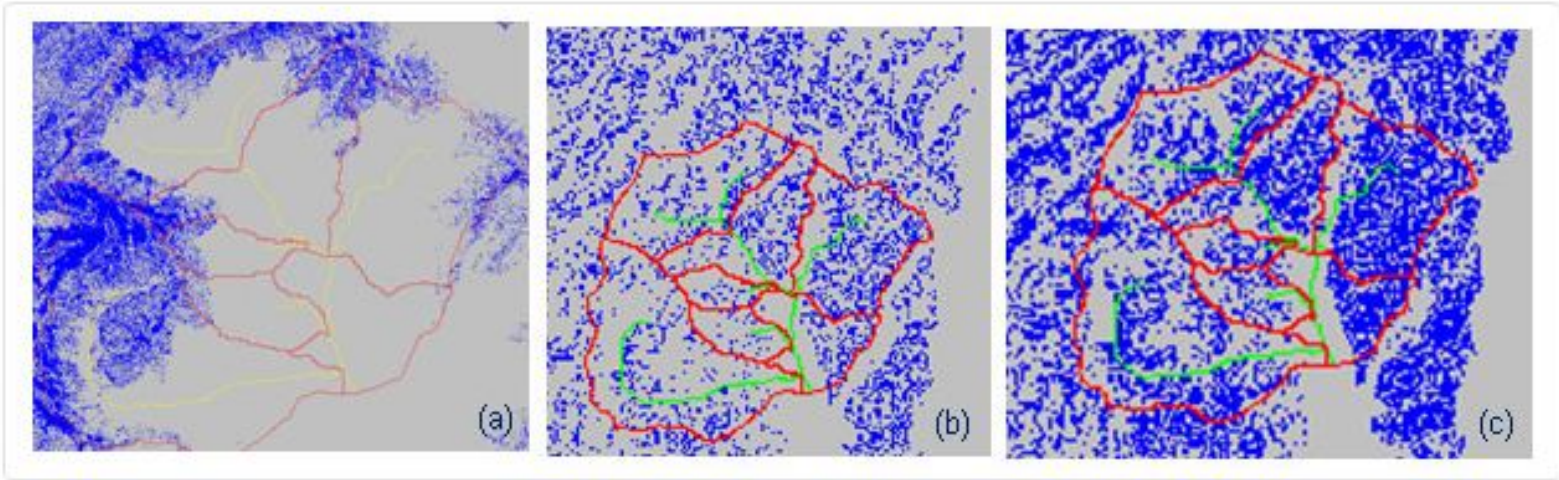
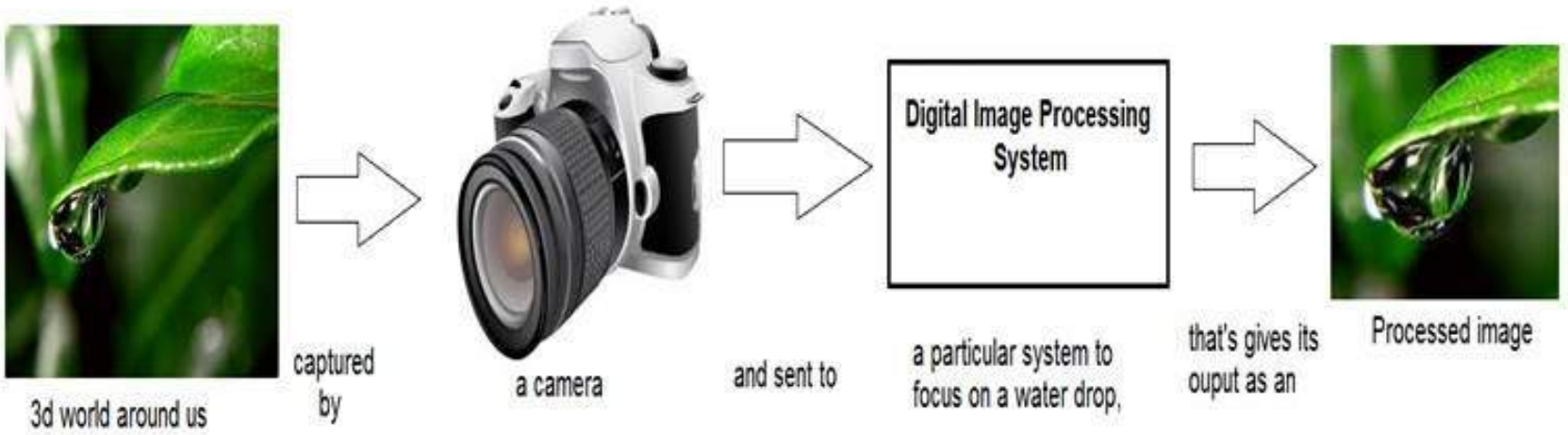
Characterizing Snow Cover in Parts of Himalaya using Active MicrowaveRem

Active microwave remote sensing, especially the synthetic aperture radar (SAR), offers all-weather and all-season im
inaccessible Himalayan snow and glacier cover. A study is carried out to use SAR data obtained from multiple sate
band ALOS-PALSAR, X-band TerraSAR-x) for mapping the spatial extent and characterizing the physical properties of s
Manali area in Himachal Pradesh State and Gangotri area in Uttarakhand State of India are taken as test sites.



How it works?

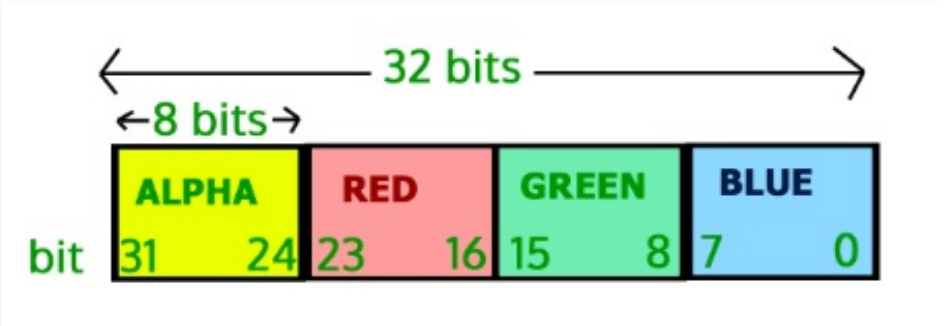
- Digital image processing deals with manipulation of digital images through a digital computer.
- DIP focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output.



Pixels

- **A Pixel** is most widely used to denote the elements of a Digital Image.
- Pixels are the smallest unit of an image which consists of four components Alpha (transparency measure), Red, Green, and Blue and in short (ARGB).
- The value Zero means the component is absent(black) and 255 means the component is fully present(White).
- Thus the bit position:

Pictorial representation of indexes:



DIP Simulator

- RBG Viewer.
- Pixel Animator.
- Data Reader.
- Noise Equailizer.
- etc.

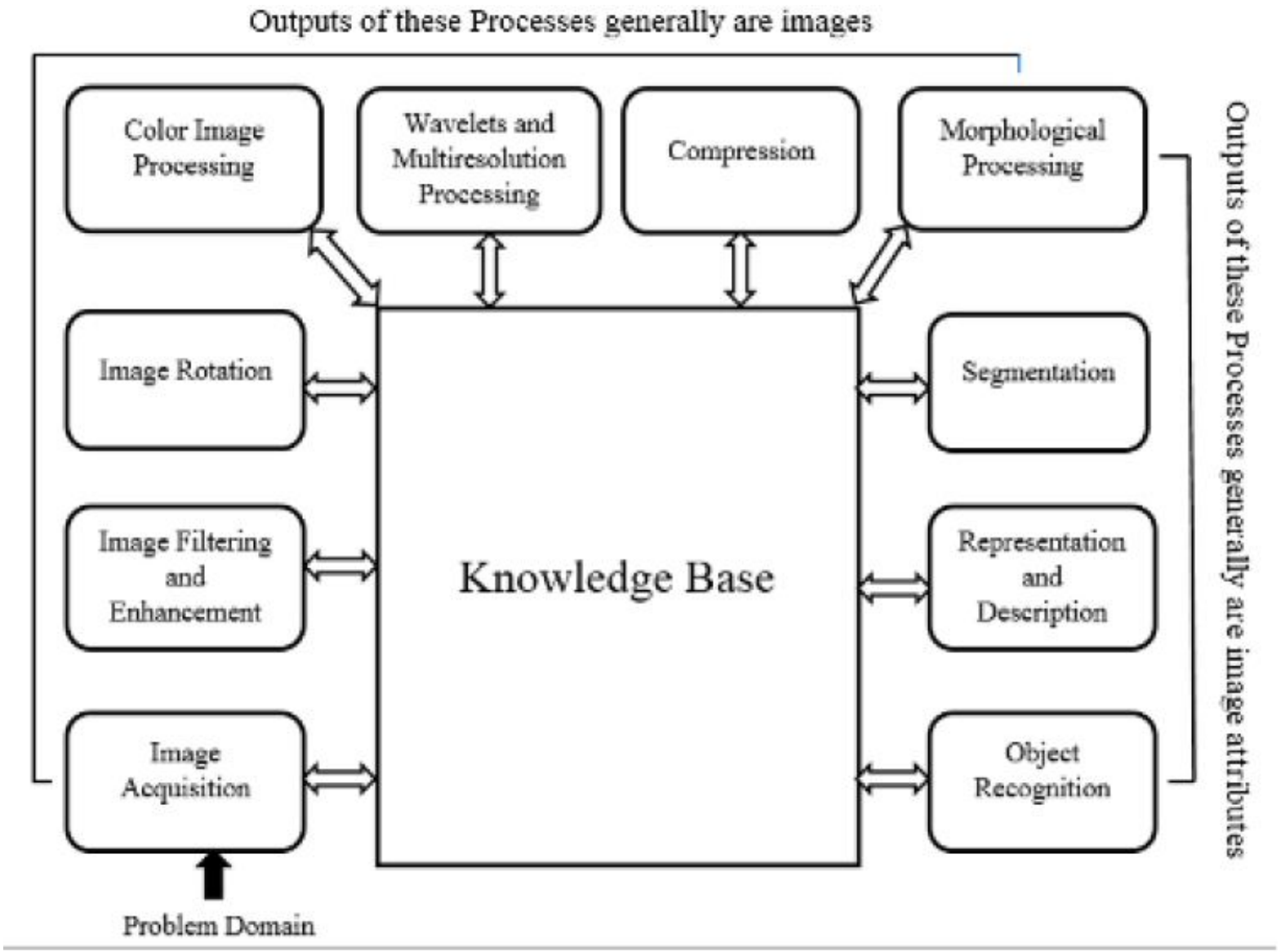
MCQ questions Related to Topic

- Q1. Black color in image processing is usually represented by the
  A. 0
  B. 1
  C. 255
  D. 256
- Q2. Intensity levels in 8-bit image are
  A. 128
  B. 255
  C. 256
  D. 512

MCQ questions Asked

- Q3. RGB colors in equal amount give
  A. white color
  B. magenta color
  C. yellow color
  D. cyan color
- Q4. RGB colors have range
  A. [0,1]
  B. [1,2]
  C. [1,0]
  D. [-1,1]

Fundamentals of Digital Imaging



Points

- Image Acquisition.
- Image Enhancement.
- Color Image processing.
- Wavelets.
- Image Compression.
- Image Segmentation.
- Knowledge Base.

Cond...

- **Image Acquisition:** Image acquisition is the process of acquiring or getting an image. The entire processing has been done on images so that, the images are first needed to be loaded to the digital computer. Eg: Digital camera, Scanner etc.
- **Image Enhancement:** Image enhancement techniques have been widely used in many applications of image processing. Image enhancement is the process of manipulating an image so that the result is more suitable than the original for a specific application.
- **Color Image processing:** Color image processing is an area that has been gaining in importance because of the significant increase in the use of digital images over the internet.

Companies working on following Projects

- **Wipro** Desktop as a Service, delivered speed and agility to virtual desktop and application management based on digital image.
- Lead the voice, gesture and image recognition revolution with Digital Signal Processing and Vision Processing.
- **Google Projects**Image Analysis Application and Image Insight using Googles Cloud Vision API.
- Image analysis is the extraction of meaningful information from images; mainly from digital images by means of digital image processing techniques.
- **Infosys**Identification of Human Act by Image Processing: This project is used to identify the human act by image processing in real time, and the main intention is to communicate the identified gestures using the camera system.

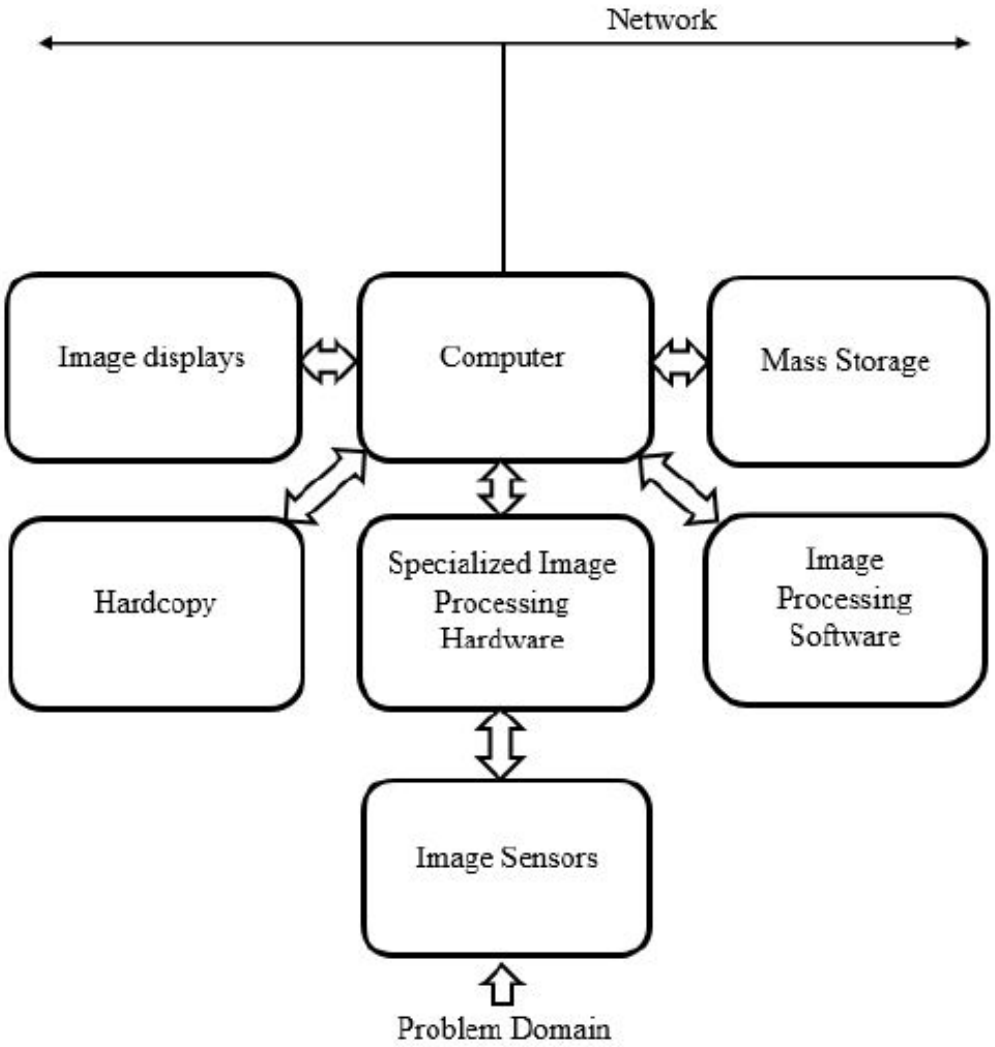
Companies working on following Projects

- Intelligent Traffic Light Control using Image Processing: Day by day the traffic issue has become a major problem in India due to the rising number of motor vehicles. For this reason, one has to utilize the traffic signals which can do the real-time checking of compactness of traffic.
- Forgery Detection of Medical Image: This project is used in the healthcare system for fake image recognition to confirm that the image is associated with the medical image or not.
- Real time Face-Detection and Emotion Recognition Using Deep learning : In this project, the problem of facial expression is addressed, which contains two different stages: 1. Face detection, 2. Emotion Recognition.

Cond...

- **Image compression:** Image compression is a technique used for reducing the storage required to store/save an image.
- **Image Segmentation:**Segmentation is the process of partitioning a digital image into multiple segments.
- **Knowledge Base:** Knowledge about a problem domain is coded into an image processing system in the form of a knowledge data base.
- **Wavelets:** Wavelets is a powerful tool in image processing, Its a mathematical function used for representing images in various degrees of resolution. It was very useful in Image compression and removal of noise.

Components Of Image Processing System.



Points

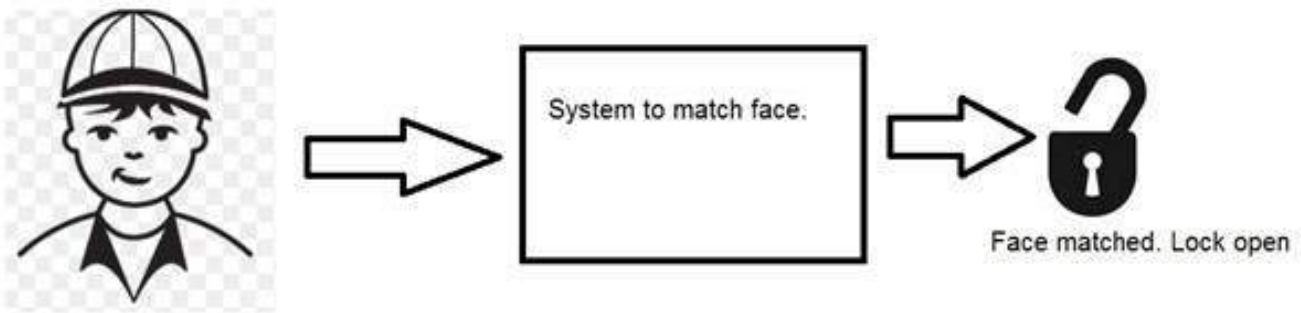
- Image sensors.
- Image processing software.
- Specialized image processing hardware.
- Image Displays.
- Hardcopy.

Cond...

- **Image sensors:** Image sensors are used to acquire a digital image.
- **Image processing software:** The software for image processing has specialized modules which perform specific tasks. Some software packages have the facility for the user to write ode using the specialized modules Eg: MATLAB Software.
- **Specialized image processing hardware:** Image processing hardware performs mostly primitive operations such as an arithmetic logic unit(ALU), that performs arithmetic and logical operations in parallel on entire images.
- **Image Displays:**Image displays are used for displaying images (eg; color TV monitors).
- **Hardcopy:**Hardcopy devices for recording images include laser printers, film cameras, heatsensitive devices, inkjet units and digital units such as optical and CD-ROM disks.

Applications of DIP

- Some of the major fields in which digital image processing is widely used are mentioned below:
- Image sharpening and restoration.
- Medical field.
- Remote sensing.
- Robot vision.
- Video processing, etc.



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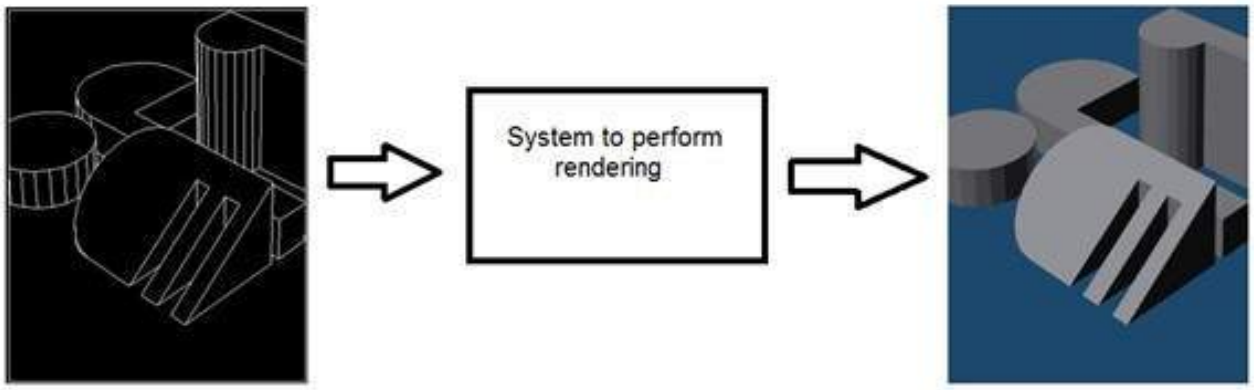
- **Computer graphics:** Computer graphics deals with the formation of images from object models, rather then the image is captured by some device.



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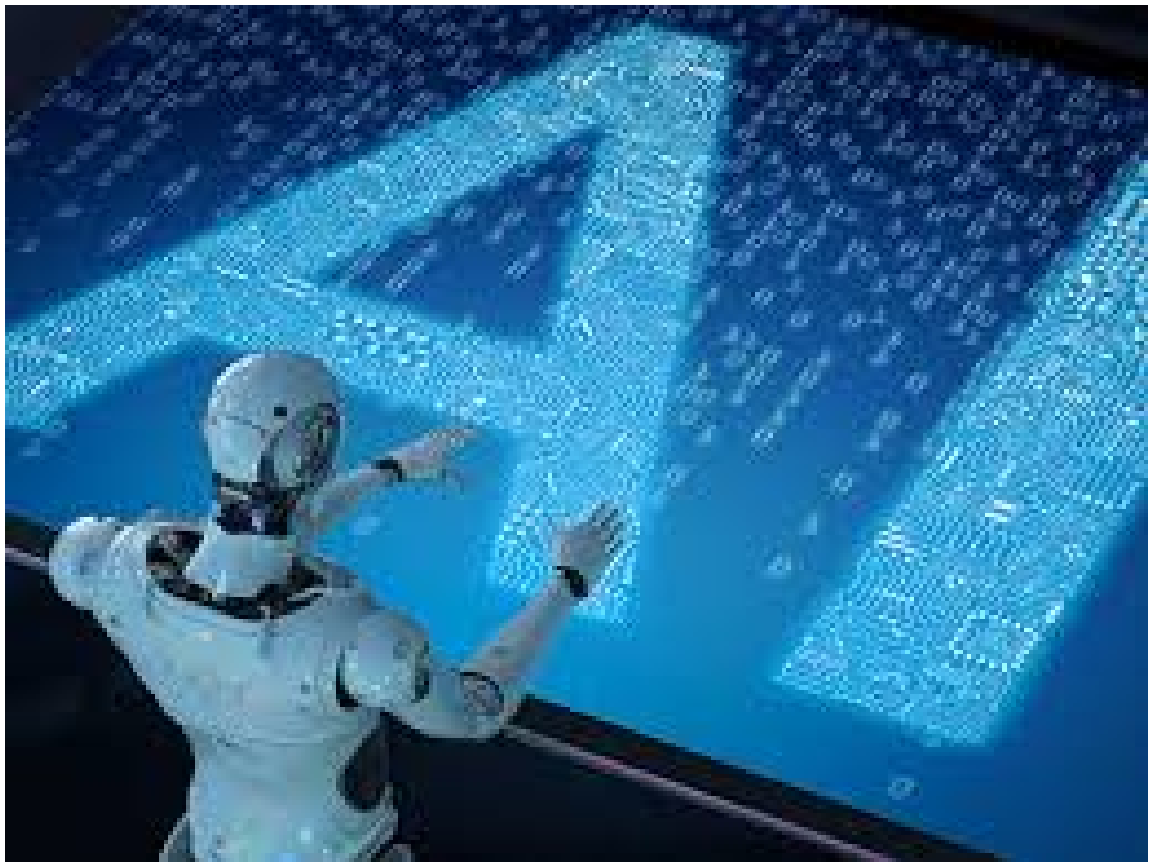
- **Artificial intelligence:** Artificial intelligence is more or less the study of putting human intelligence into machines. Artificial intelligence has many applications in image processing.



Queries

Thanking You