Intelligence Academy

Mathematical Foundations of Image Processing and Computer Vision : Chapter 01: What Is Image Processing

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What Is Image Processing?

Definition

Image Processing refers to the method of performing operations on an image to enhance it or extract useful information. It is a type of signal processing in which input is an image and output may be an image, a set of features, or parameters associated with the image.

> **Formal Definition:** Image Processing is a technique to perform operations on digital images, such as filtering, enhancement, segmentation, or compression, using mathematical algorithms.

Types of Image Processing

Image Processing is typically categorized into the following types:

1. Analog Image Processing

- Deals with two-dimensional analog signals.
- Used in television broadcasting, radar systems, and photographic processing.
- Requires analog devices such as optical filters and lenses.

2. Digital Image Processing

- Involves the use of computers to process digital images.
- Uses algorithms to perform tasks like denoising, sharpening, and segmentation.

Types of Image Processing

- Enables complex and precise manipulations such as deep learning-based recognition.

Major Steps in Digital Image Processing

1. **Image Acquisition** – Capturing image data via sensors.
2. **Preprocessing** – Enhancing quality, removing noise.
3. **Segmentation** – Dividing image into meaningful regions.
4. **Feature Extraction** – Identifying patterns or descriptors.
5. **Recognition** – Classifying objects using features.
6. **Post-Processing** – Refining outputs for interpretation or display.

Goals of Image Processing

- Improve the visual quality of images (enhancement).
- Extract meaningful features or patterns.
- Compress image data for storage and transmission.
- Restore images degraded by noise, motion, or distortion.
- Prepare data for computer vision or AI models.

Applications of Image Processing

- **Medical Imaging** – MRI, CT Scan, X-ray enhancement.
- **Satellite Image Analysis** – Weather forecasting, terrain mapping.
- **Industrial Inspection** – Defect detection in products.
- **Biometric Systems** – Face and fingerprint recognition.
- **Digital Photography** – Filters, HDR, denoising.

Important Points

- Digital image processing allows reproducibility, flexibility, and precision.
- It is based on mathematical and algorithmic foundations.
- Image processing is a precursor to Computer Vision and Machine Learning.
- Involves both low-level (enhancement) and high-level (recognition) operations.

Conclusion

Image Processing is a foundational discipline in artificial intelligence, robotics, remote sensing, and multimedia. It bridges raw image acquisition with meaningful visual understanding through mathematical models and algorithms.