Digital Image Processing

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Introduction

What is Digital Image Processing?

- Digital Image
  — a two-dimensional function
  x and y are spatial coordinates
  The amplitude of f is called intensity or gray level at the
  point (x, y)
  Components are called pixels.

- Digital Image Processing
  — process digital images by means of computer

  low-level: inputs and outputs are images
  mid-level: outputs are attributes extracted from input
  images
  high-level: an ensemble of recognition of individual
  objects

Components

Figure: Components of Image Processing
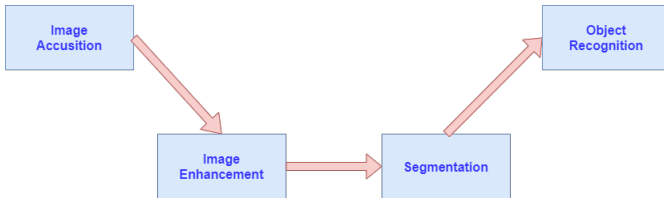
Process of Image Acquisition

The Image Acquisition is purely Hardware Dependent Process, in which reflected light energy from the object being imaged is converted into electrons and spread over the internal sensor chip which is like a 2-D array of cells is cell is called photosite and contain amount of charges which is further converted to digital form using Analog to Digital Converter.

Now this digital image can be used for enhancement, restoration, segmentation and other manipulations

Image Acquisition
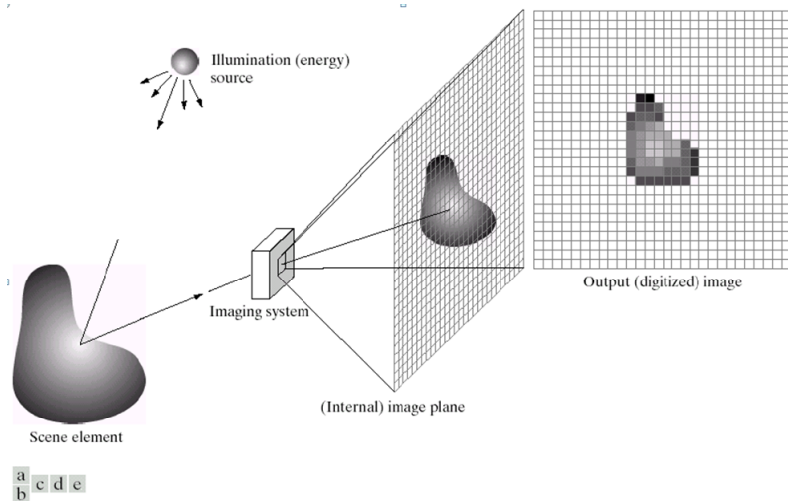
FIGURE :   An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Image Enhancement

- **Image Enhancement process** consists of collection of techniques that seek to improve the visual appearance of the image or to convert the image to a form better suited for analysis.
- **The principle idea** of image enhancement is to modify the attributes of an image to make it more suitable for
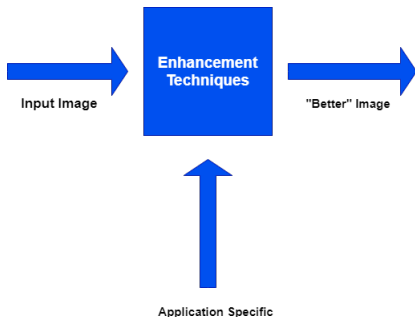
Enhancement Techniques

The image enhancement techniques can be divide into two main categories:

- Spatial Domain Techniques
  These techniques are performed to the image plane itself and they are based on direct manipulation of pixels in an image.
  The operation can be formulated as $g(x, y) = T[f(x, y)]$, where g is the output, f is the input and T is some operation on f defined over some neighborhood of (x, y).
  e.g., **Contrast Enhancement, Sharpening.**

Enhancement Techniques

The image enhancement techniques can be divide into two main categories:

- Frequency Domain Techniques
  In this techniques the image is first transferred into frequency domain using Fourier Transform. Then the Enhancement operations are performed on Fourier transform of the image and then the Inverse Fourier Transform is calculated to get the resultant image.
 $f(x, y) \rightarrow F(u, v) rightarrow G(u, v) = H(u, v)F(u, v), G(u, v) \rightarrow g(x, y)$
  e.g. **Low-pass, High-pass filtering.**

Segmentation

Image Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as image objects). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.
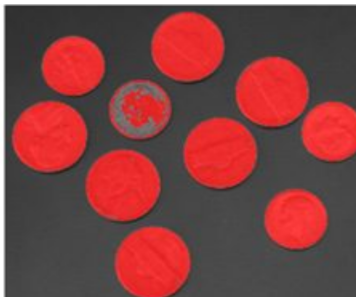
Segmentation Techniques

There are various segmentation techniques. Some are mentioned below:

- Histogram Based
  1. Thresholding
  2. Clustering
- Motion Based
- Discontinuity Based
  1. Point detection
  2. Line detection
  3. Edge detection
- Similarity Based
  1. Region growing

Object Recognition

Object recognition is a general term to describe a collection of related computer vision tasks that involve identifying objects in digital photographs.

These tasks often comprises of the following tasks:-
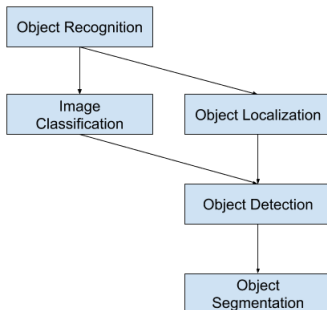
Object Recognition Tasks

We can distinguish between these three computer vision tasks:

- **Image Classification:** Predict the type or class of an object in an image.
    - **Input:** An image with a single object, such as a photograph.
    - Output: A class label (e.g. one or more integers that are mapped to class labels).

- **Object Localization:** Locate the presence of objects in an image and indicate their location with a bounding box.
    - **Input:** An image with one or more objects, such as a photograph.
    - **Output:** One or more bounding boxes (e.g. defined by a point, width, and height).

- **Object Detection:** Locate the presence of objects with a bounding box and types or classes of the located objects in an image.
    - **Input:** An image with one or more objects, such as a photograph.
    - **Output:** One or more bounding boxes (e.g. defined by a point, width, and height), and a class label for each bounding box.

Thank You

The slides for the today's presentation can be downloaded from:
https://github.com/AnubhavMehraCS/Paper2/raw/main/imageprocessing.pdf

References:

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2 https://www.slideshare.net/surabhiks5/image-enhancement-ppt-nal2

3 https://en.wikipedia.org/wiki/Image_segmentation

4 https://machinelearningmastery.com/object-recognition-with-deep-learning/