

Image Processing

Image processing:

- Can be defined as a two dimensional function $f(x, y)$.
 - Amplitude of f at any pair of coordinates (x, y) called the intensity of the image.
- Composed of a finite number of elements called points (pixels).
- method to perform some operations on image, in order to an enhanced image.
- the technology of applying a number of computer algorithms to process digital images and The outcomes of this process can be either **images** or a **set of representative characteristics** or **properties of the original images**.
- The main purpose of image processing is to allow human beings to obtain an image of high quality or descriptive characteristics of the original image.

applications of image processing:

- robotics/intelligent systems.
- medical imaging.
- remote sensing.
- Photography.
- Forensics.

Image processing steps:

1. Image Acquisition
2. Image Enhancement
 - The process of manipulating images so that the result is more suitable than the original for a specific application.
 - Ex highlighting interesting details, removing noise, revealing blurred details.
 - Problem oriented technique.
3. Image Restoration

- A process that seeks to recover an image that has been corrupted in some way using neighboring pixels.
- 4. Color Image Processing
- 5. Wavelets and Multiresolution Processing
- 6. Compression
- 7. Morphological Processing
- 8. Segmentation
- 9. Representation and Description
- 10. Object recognition
- 11. Knowledge Base.

Image:

- an array, or a matrix, of square pixels (picture elements) arranged in columns and rows.

image matrix:

- defines the number of row and columns in our image that make up the pixels / voxels in our image.
- These rows and columns are determined by the number of phase and frequency encoding steps.

Image shapes(types):

1) Binary image

- Have only two values and colors 0 for black and 1 for white.
- Have only two grey levels.
- Represented using one bit per pixel.
- often created from the grey-scale images via a threshold operation.
- [Ex](#) OCR optical character recognition.

2) Greyscale image

- Have many shades of grey between black and white.

- The range of shades between 0 to 255.
- Represented using 8 bits (byte) per pixel (may use additional bits to cover noise margins).
- Have 256 grey levels.

3) Colored image

- the basic color model (additive model) that mixing the primary colors red, green, blue.
- Represented using 24 bits (3 byte) per pixel.
- Each pixel has 3 arrays.

	input	output
Image processing	image	image
Computer graphic	Instructions(source code)	Graphic image
Computer vision	image	description

Basic intensity transformation functions:

1) Linear (negative) transform

- invert of identity transformation.
- each value of the input image is subtracted from the L-1 and mapped onto the output image.
- range $[0, L-1]$ (or) $\{0, 1\}$
- $s = (L - 1) - r$ (or) $s = 1 - r$.
- suitable for enhancing white or grey details embedded in black regions of images.
- Not suitable to improve brightness.

2) Greyscale transform

- called thresholding function.
- Range $[0, 255]$.
- $S = 1 - r/256$.

3) Power law (Gamma) transform.

- Range $[0, 1]$.
- $s = c * (r^\gamma)$ where γ is called gamma.

- If gamma increases (greater than 1), the darkness increases.
- If gamma decreases (lower than 1), the brightness increases.
- Suitable to improve brightness.

Filters:

- Remove blurring from images.
- Highlight edges.

- ✚ Resolution increase when number of pixels increase, decrease when number of pixels decrease (pixel distortion).
- ✚ JPEG (Joint Photographic Experts Group).
- ✚ ROI (region of interest).
- ✚ Image space = row pixel * Colum pixel * grey level.

K-Means:

- A cluster refers to a collection of data points aggregated together because of certain similarities.
- k number of centroids.
- allocates every data point to the nearest cluster.
- **means** in the K-means refers to **averaging** of the data.
- Unsupervised.
- Advantages
 1. Simple to implement.
 2. Scales to large data sets.
 3. Easily adapts to new examples.
- Disadvantages
 1. Choosing k manually.
 2. Dependent on initial values.
 3. Scaling with number of dimensions.

K-NN (nearest neighbor):

- one of the simplest Machine Learning algorithms based on Supervised Learning technique.
- can be more effective if the training data is large.
- stores all the available data and classifies a new data point based on the similarity.
- a non-parametric algorithm.
- K is the number of nearest neighbors.
- K is **generally** an odd number عادی لو زوجي بس يفضل يکون فردی.
- A very low value for K such as K=1 or K=2, can be noisy and lead to the effects of outliers in the model.
- Large values for K are good, but it may find some difficulties.
- **Classification** is a process related to categorization, the process in which ideas and objects are recognized, differentiated and understood. Classification is the grouping of related facts into classes.

✚ The Euclidean distance between two 2-D points I(x1, y1) and J(x2,y2) is defined as:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$