Spatial operations

I

* It is performed directly on the pixels of a given image.

Classification :-

1) Single pixel operations
2) Neighborhood operations
3) geometric Spatial operations

1) Single pixel operations

* Simple operation
* To alter the values of its individual pixels based on their intensity
* This process may be expressed as a transformation function, T of the form.

$$S = T(z) \quad \text{--- (1)}$$

where z is the Intensity of a pixel in the processed image.

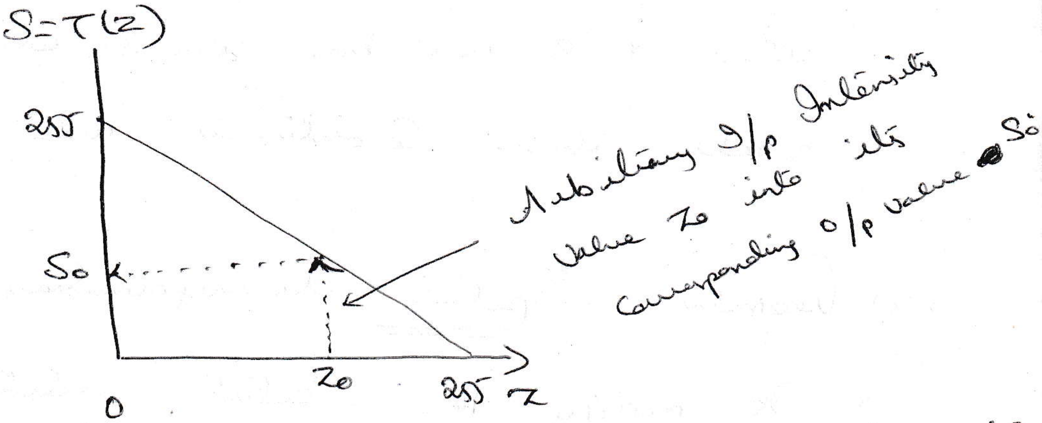
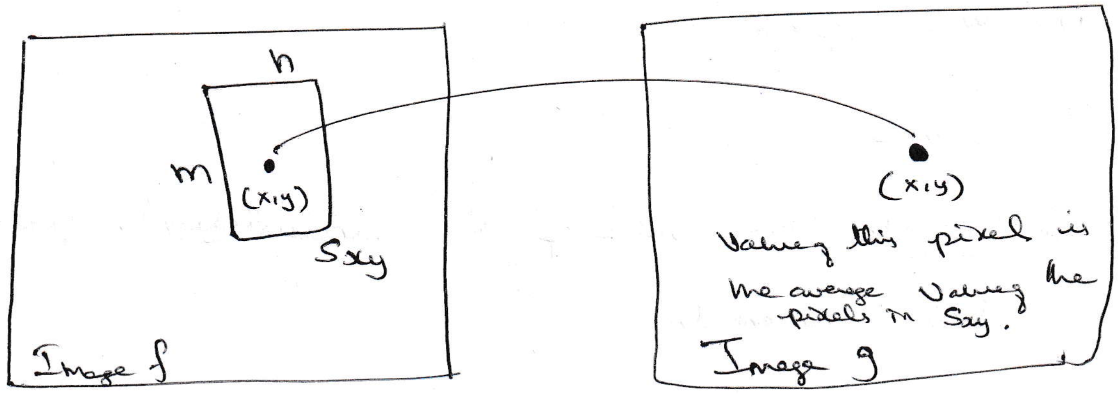


Fig (1): Intensity transformation function used to obtain the negative of an 8 bit image.

2) Neighborhood operations :-

* Let S_{xy} denote the set of co-ordinates of a neighborhood centered on an arbitrary point (x,y) in an image, f.
* Neighborhood processing generates a corresponding pixel at the same co-ordinates in an o/p (processed) image, g
* Such that the value of that pixel is determined by a specified operation involving the pixels in the input image with coordinates in $S_{x,y}$.



Local averaging using neighborhood processing.

$$g(x,y) = \frac{1}{mn} \sum_{r,c \in S_{xy}} f(r,c). \quad \text{——— (2)}$$

where r & c are the row & column co-ordinates of the pixels whose co-ordinates are members of the set S_{xy}.

3) Geometric Spatial transformations and image registration.

Geometric ↓

* It modify the spatial relationship between pixels in an image ⟹ rubber - sheet transformations

⇓

analogous to printing an image on a sheet of rubber

In terms of Image processing, Geo transformations consists of 2 basic operations.

i) Spatial transformation of co-ordinates.

ii) Intensity interpolation => that assigns intensity values to the spatially transformed pixels.

* Transformation of Co-ordinates.

$$(x, y) = T\{(v, w)\}. \quad — ③$$

(x, y) ↓ pels in transformed image

(v, w) ↓ pels in original image

Ex:

$$(x, y) = T\{(v, w)\} = (v/2, w/2)$$ => Shrinks the original image to half its size in both spatial directions.

* Commonly used Spatial Co-ordinate transformation is the affine transform, which has the general form

$$[x \; y \; 1] = [v, w, 1]\,T = [v \; w \; 1] \begin{bmatrix} t_{11} & t_{12} & 0 \\ t_{21} & t_{22} & 0 \\ t_{31} & t_{32} & 1 \end{bmatrix} \quad — ④$$

Ex: Resize image => Rotate it
move the result to some location

i.e Form 3×3 matrix = Scaling × rotation × translation matrices.

we can use Eqn. (4) in 2 ways

i) forward mapping

ii) Inverse mapping.

Forward mapping

* Scanning → I/p image
* problem ⇒ 2 (or) more pixels transformed to same location → multiple output values.

Inverse mapping.

* Scans the o/p image & computes corresponding location.
* $(v,w) = T^{-1}(x,y)$., Interpolates among neighbourhood.
* It is more efficient.

Image registration :-

* It is used to allign (register) 2 (or) more images of the same scene.

I/p image → we wish to transform.
Ref " → Image against we want to register the I/p

Eg MRI, PET etc.,

Problems. [overcome]

* tie points - control points.
* known points - physical artifacts [metallic objects]. Research marks.