Escuela Profesional de
Ciencia de la Computación

Computer graphics

Histogram Equalization

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Overview

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Objectives

- Understand the difference between point, local and operators in image processing.

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Objectives

- Understand the difference between point, local and operators in image processing.
- Learn Histogram Equalization method.

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Sample application

Figure: Sample application in pattern recognition

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Sample application

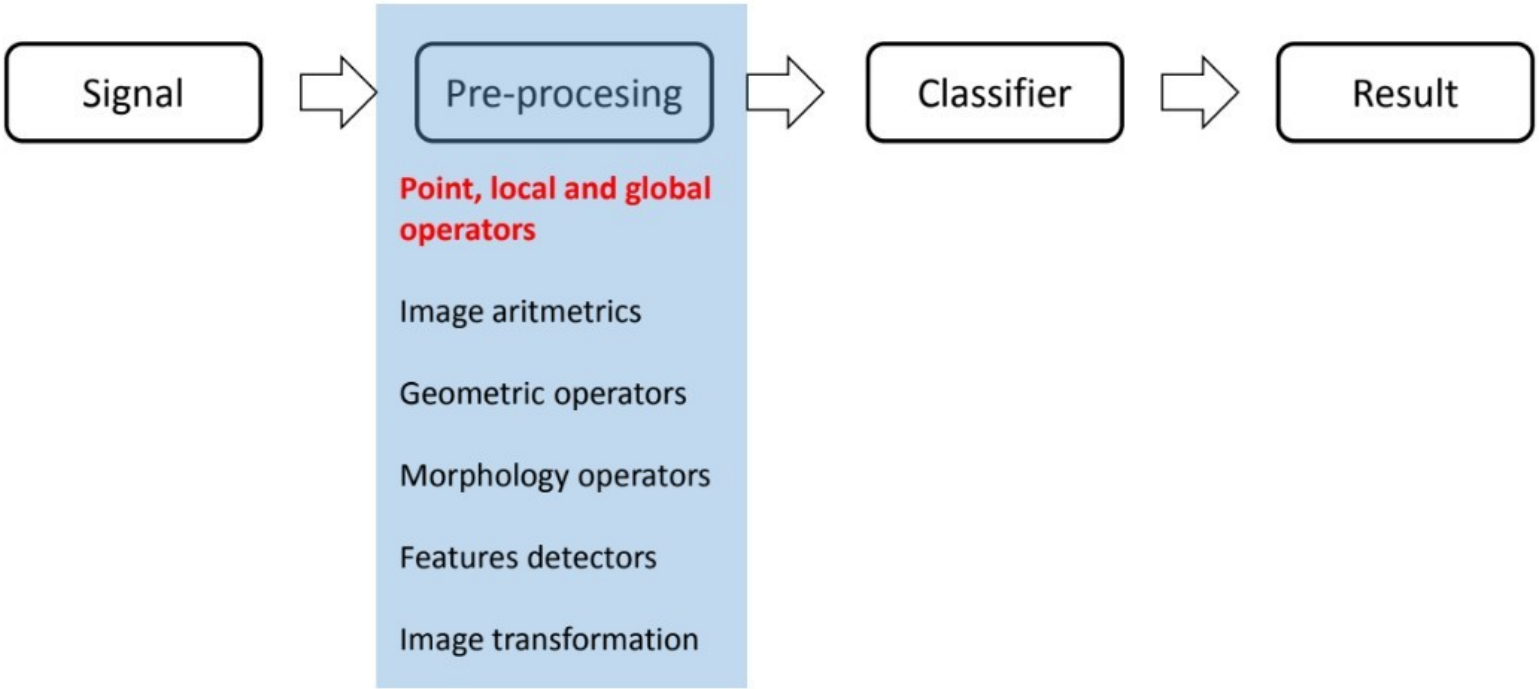

Figure: Sample application in pattern recognition

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Point operators

Example

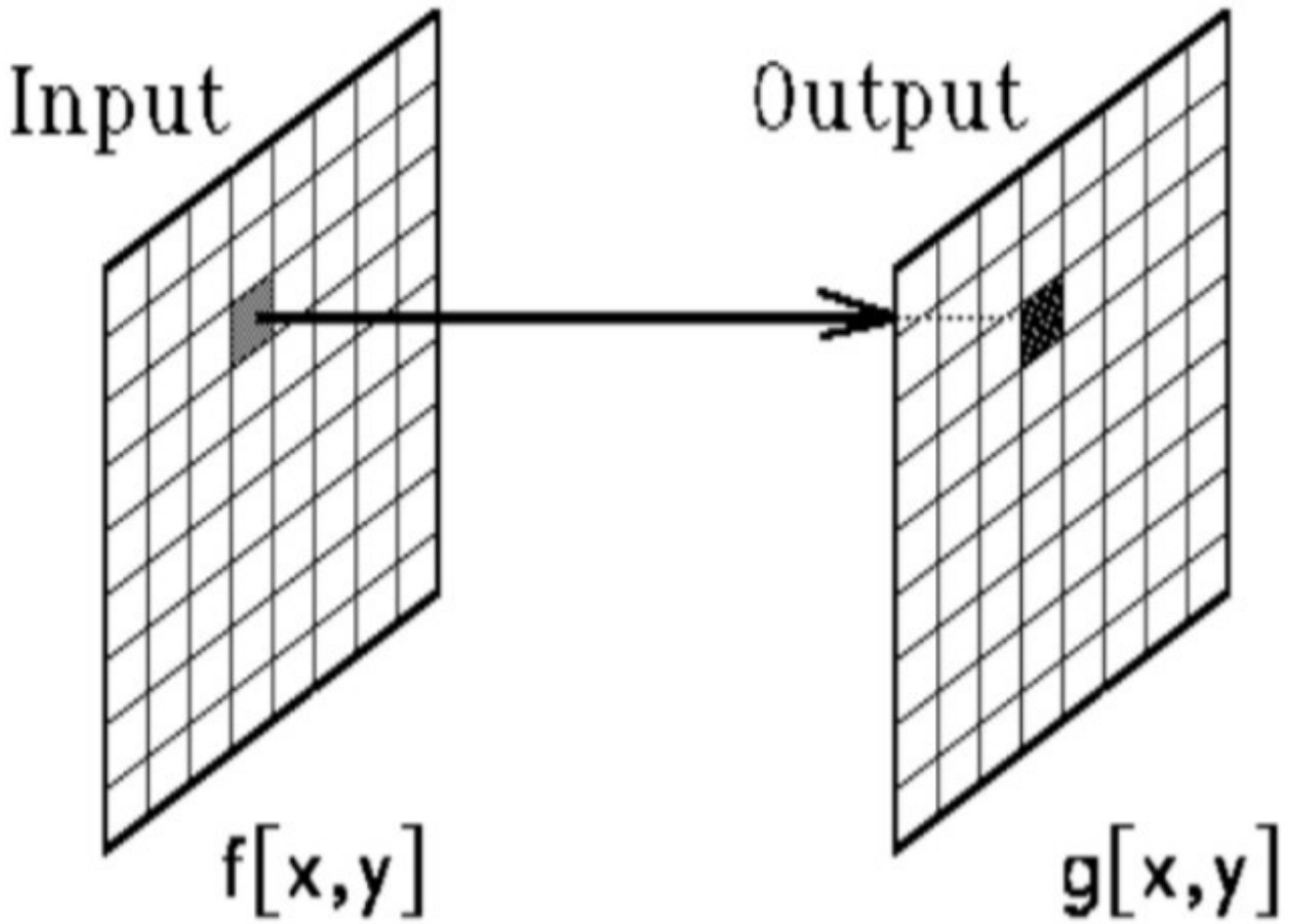

Figure: Point operator.

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Point operators

Formal definition

Point operator

$$O\{f[x,y]\} = g[x',y']$$

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Point operators

Examples

- Thresholding
- Contrast Stretching
- **Histogram Equalization**
- Logarithm Operator
- Exponential/Raise to Power Operator

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Histogram Equalization

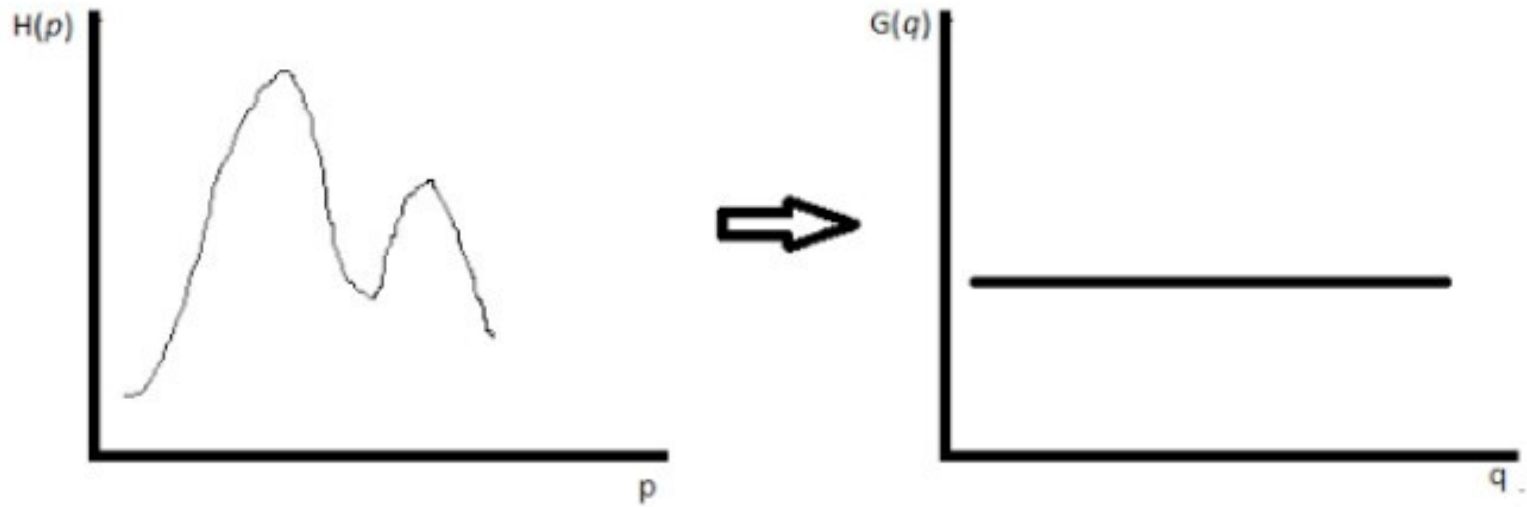

Figure: Histogram equalization employs a monotonic, non-linear mapping which re-assigns the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities. This technique is used in image comparison processes (because it is effective in detail enhancement).

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Histogram Equalization

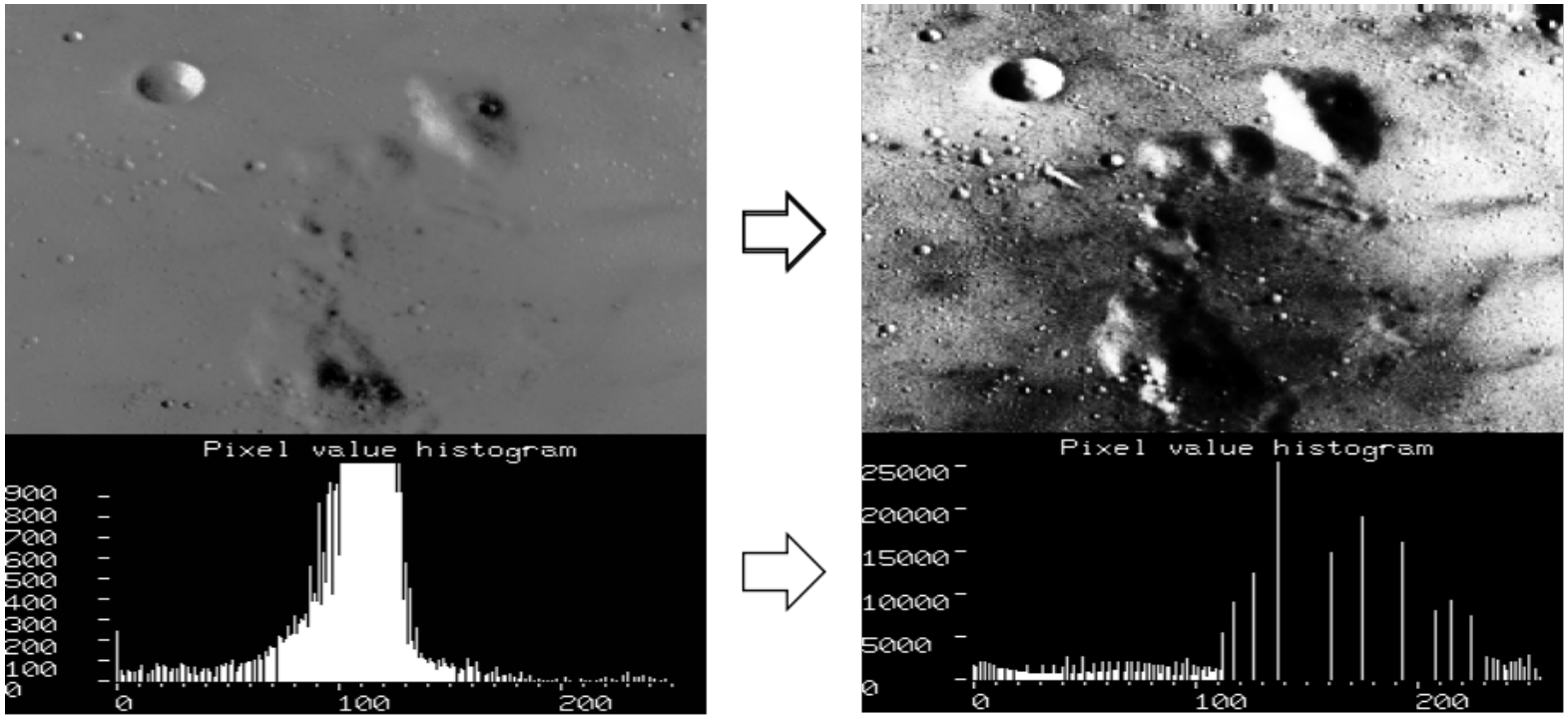

Figure: Example of Histogram Equalization.

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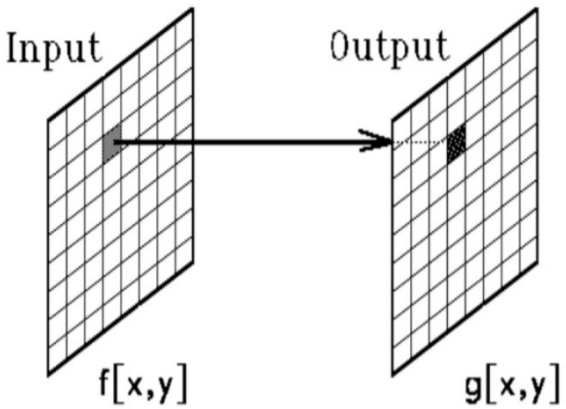
Histogram Equalization



$$g[x,y] = s_{f[x,y]}$$

$$s_n = \text{floor}\left((L-1)\sum_{j=0}^{n} P_n\right)$$

$$P_n = \frac{\text{number of pixels with intensity } \boldsymbol{n}}{\text{total number of pixels}}$$

$$n = 0, 1, ..., L-1$$

Where:

- L : Pixel intensity length (256).

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Histogram Equalization

Example: Suppose we have a 3-bits image ($L = 8$) of $64x64$ size ($m * n = 4096$) which have the distribution:

n	histogram	p_n
0	790	0.19
1	1023	0.25
2	850	0.21
3	656	0.16
4	329	0.08
5	245	0.06
6	122	0.03
7	81	0.02

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Histogram Equalization

$$s_n = (L-1)\sum_{j=0}^{n} P_n$$

$$s_0 = (7)\sum_{j=0}^{n} P_r(r_j) = 7P_0 = 7(0.19) = 1.33$$

$$s_1 = (7)\sum_{j=0}^{n} P_r(r_j) = 7(P_1 + P_0) = 3.08$$

- $s_2 = 4.55$
- $s_3 = 5.67$
- $s_4 = 6.23$
- $s_5 = 6.65$
- $s_6 = 6.86$
- $s_7 = 7.00$

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Histogram Equalization

Values s_k:

- $s_0 = 1.33$
- $s_1 = 3.08$
- $s_2 = 4.55$
- $s_3 = 5.67$
- $s_4 = 6.23$
- $s_5 = 6.65$
- $s_6 = 6.86$
- $s_7 = 7.00$

Floor:

- $s_0 = 1$
- $s_1 = 3$
- $s_2 = 4$
- $s_3 = 5$
- $s_4 = 6$
- $s_5 = 6$
- $s_6 = 6$
- $s_7 = 7$

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Histogram Equalization

Example

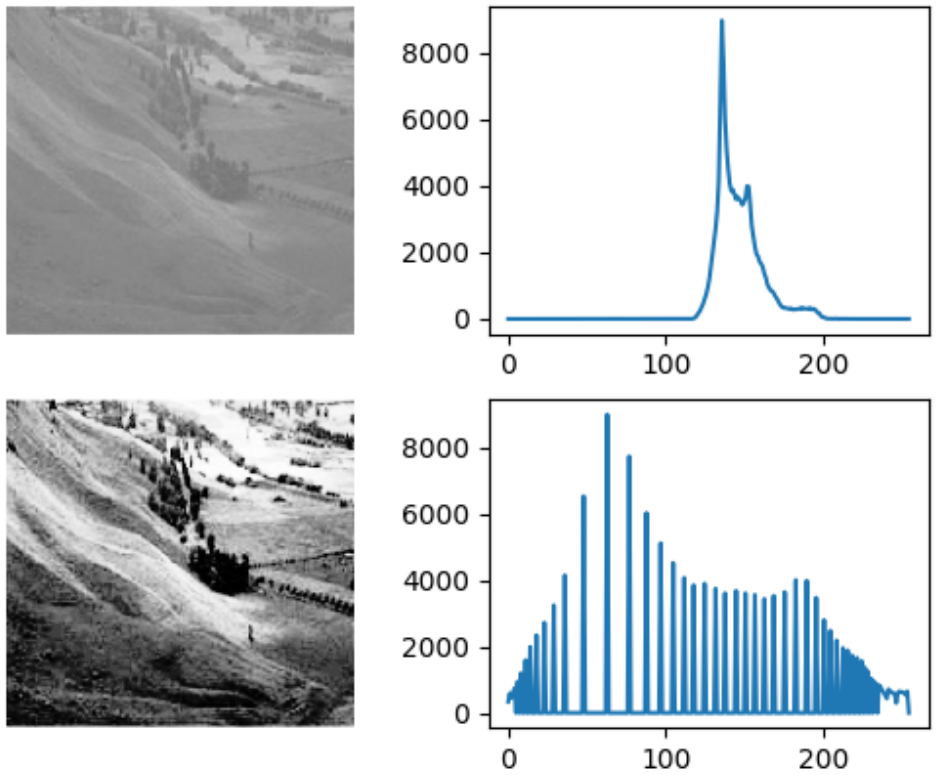

Figure: Example of Histogram Equalization.

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Histogram Equalization

Local histogram equalization example

Figure: Original image.

Figure: Image after histogram equalization.

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Histogram Equalization

Local histogram equalization example

Figure: Sub image use to compute s_n.

Figure: Image after local histogram equalization.

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Questions?

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