Lecture 4 Point Operators

COMP3204 & COMP6223 Computer Vision

How many different operators are there which operate on image points?

Book
pp
85-98

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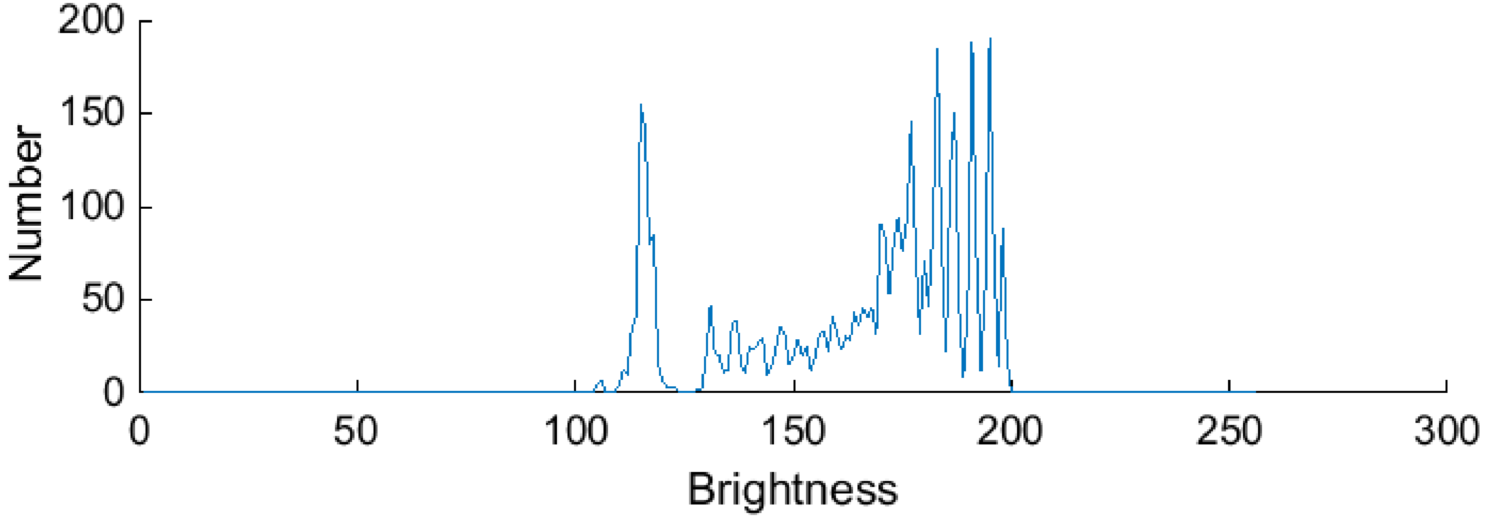
An image and its histogram

(a) image of an eye



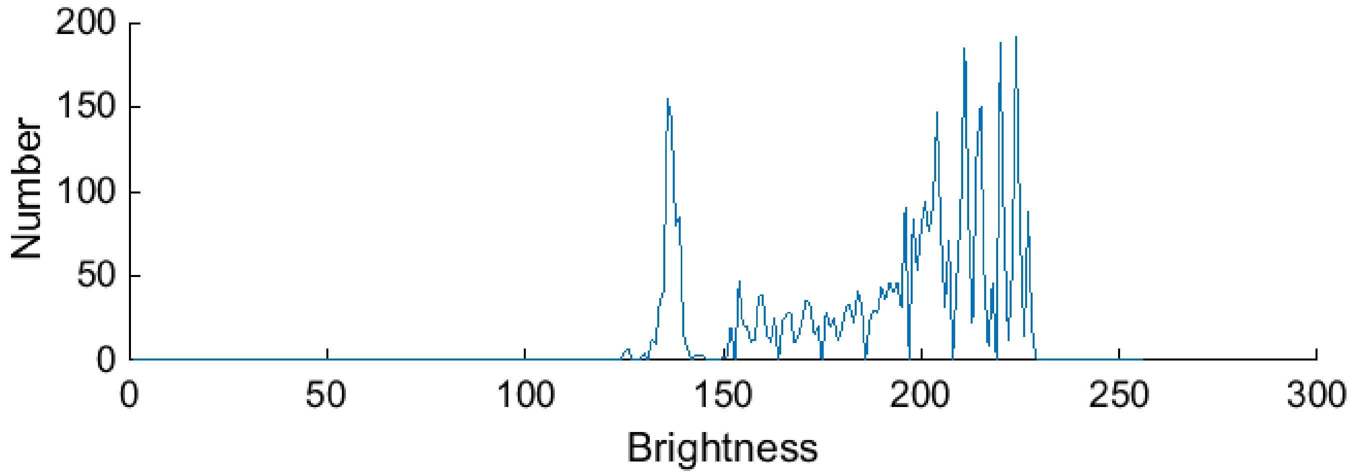
(b) histogram of eye image

Brightening an image

$$\mathbf{N}_{x,y} = k \times \mathbf{O}_{x,y} + l$$

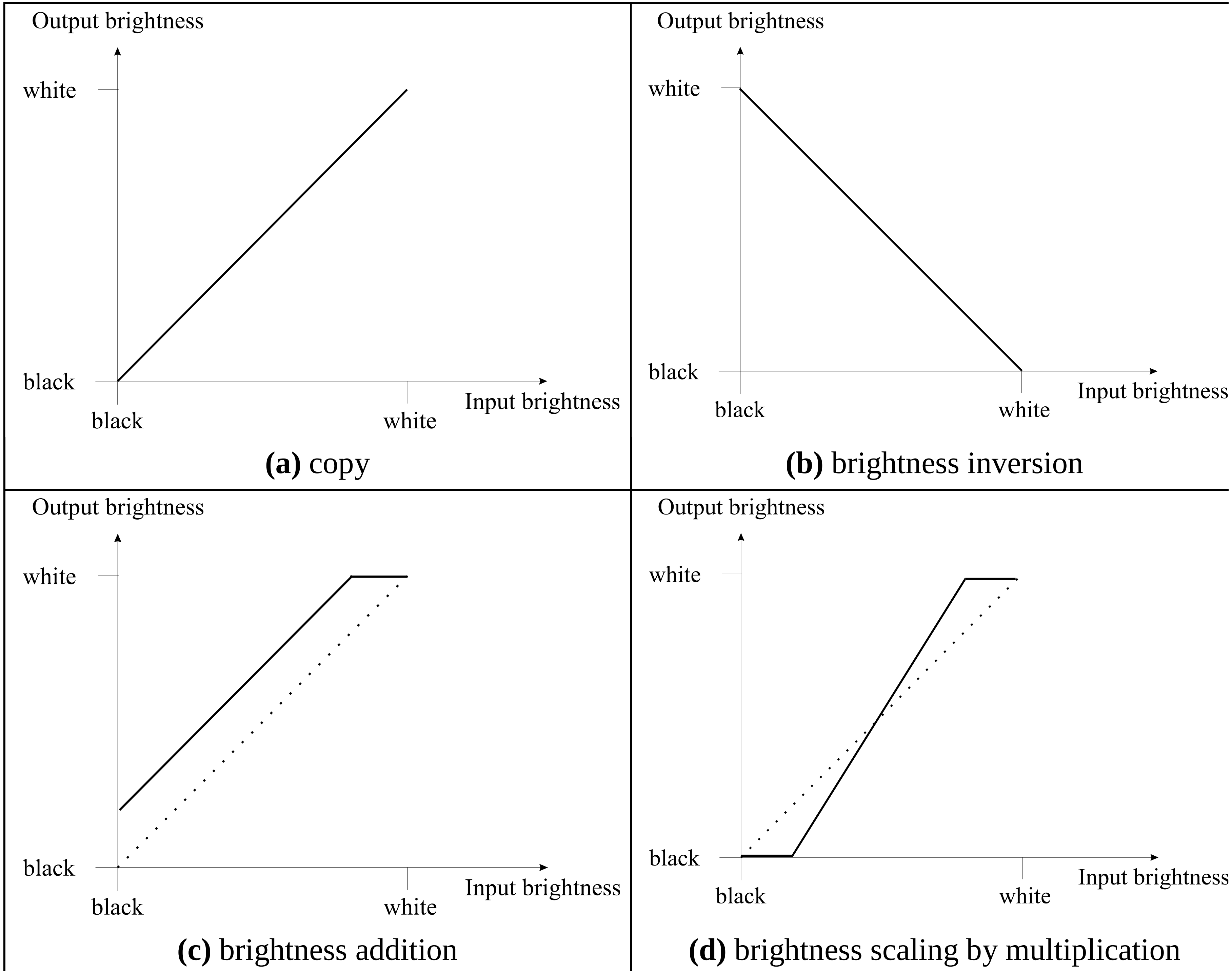
new image **N**; old image **O**; gain *k*; level *l*; co-ordinates *x*,*y*

(a) image of brighter eye



(b) histogram of brighter eye

Intensity mappings



(a) copy

(b) brightness inversion

(c) brightness addition

(d) brightness scaling by multiplication

Applying exponential and logarithmic point operators

(a) logarithmic compression

(b) exponential expansion

$$\mathbf{N}_{x,y} = \log\left(\mathbf{O}_{x,y}\right)$$

$$\mathbf{N}_{x,y} = \exp\left(\mathbf{O}_{x,y}\right)\cdot$$

Intensity normalisation

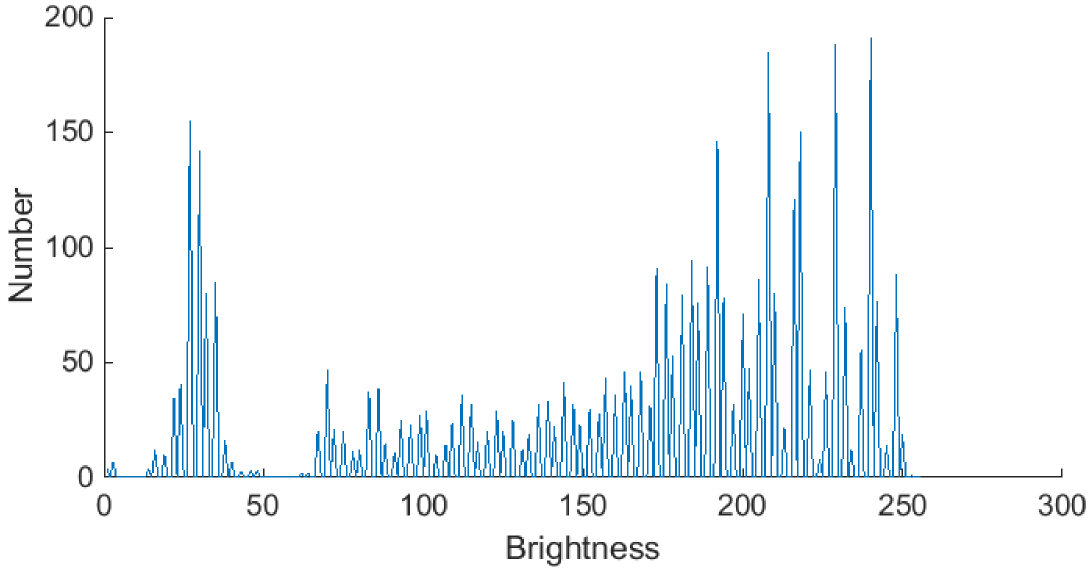
$$\mathbf{N}_{x,y} = \frac{\mathbf{N}max - \mathbf{N}min}{\mathbf{O}max - \mathbf{O}min} \times \left(\mathbf{O}_{x,y} - \mathbf{O}min\right) + \mathbf{N}min \qquad \forall x, y \in 1, N$$

new image **N**; old image **O**; co-ordinates *x,y*
minimum input **N***min*
maximum input **N***max*
minimum output **O***min*
maximum output **O***max*

Avoids need for parameter choice

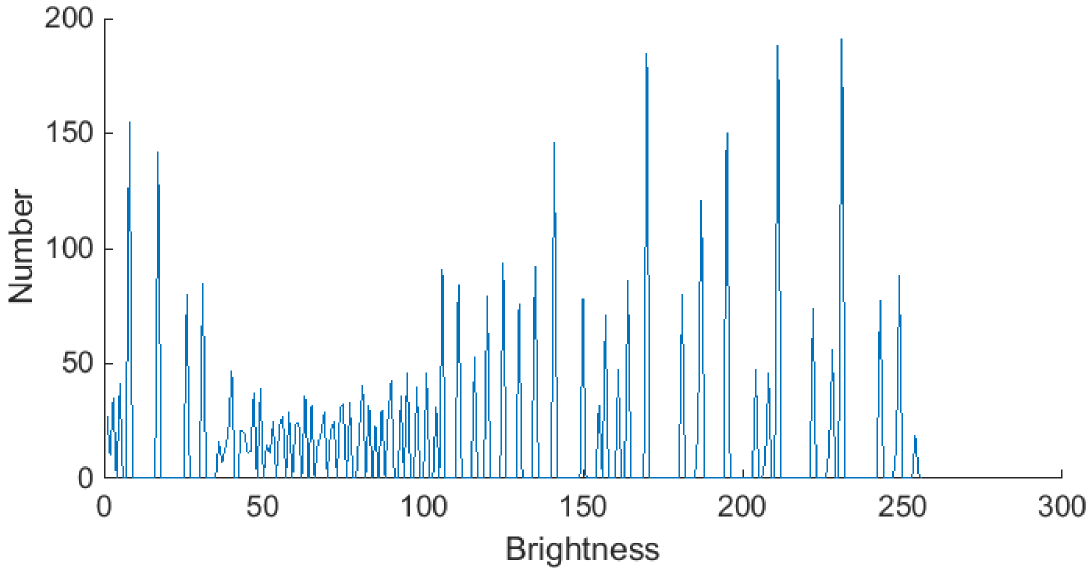
Intensity normalisation and histogram equalisation

(a) intensity normalised eye



(b) histogram of intensity normalised eye

(c) histogram equalised eye



(d) histogram of histogram equalised eye

Histogram Equalisation

N^2 points in the image; the sum of points per level is equal $$\sum_{l=0}^{M} \mathbf{O}(l) = \sum_{l=0}^{M} \mathbf{N}(l)$$

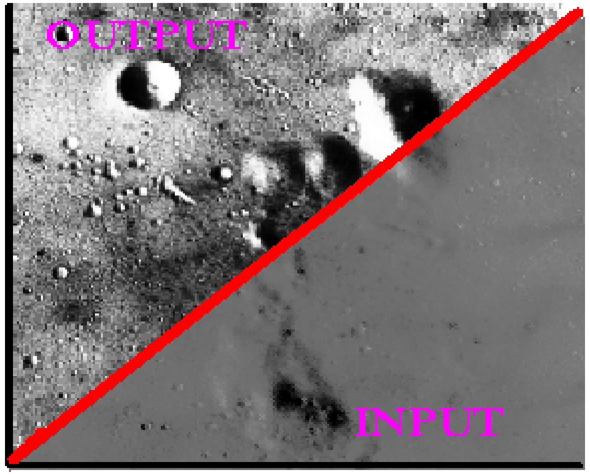
cumulative histogram up to level p should be transformed to cover up to the level q $$\sum_{l=0}^{p} \mathbf{O}(l) = \sum_{l=0}^{q} \mathbf{N}(l)$$

number of points per level in the output picture $$\mathbf{N}(l) = \frac{N^2}{\mathbf{N}max - \mathbf{N}min}$$

cumulative histogram of the output picture $$\sum_{l=0}^{q} \mathbf{N}(l) = q \times \frac{N^2}{\mathbf{N}max - \mathbf{N}min}$$

mapping for the output pixels at level q $$q = \frac{\mathbf{N}max - \mathbf{N}min}{N^2} \times \sum_{l=0}^{p} \mathbf{O}(l)$$

Applying intensity normalisation and histogram equalisation



http://homepages.inf.ed.ac.uk/rbf/HIPR2/histeq.htm;
http://docs.opencv.org/doc/tutorials/imgproc/histograms/histogram_equalization/histogram_equalization.html ;
http://www.softpedia.com/get/Multimedia/Video/Other-VIDEO-Tools/Easy-Histogram-Equalization.shtml

Thresholding an eye image

$$\mathbf{N}_{x,y} = \begin{cases} 255 & \text{if} \quad \mathbf{N}_{x,y} > \textit{threshold} \\ 0 & \textit{otherwise} \end{cases}$$

Thresholding an eye image: manual vs automatic

	
(a) thresholding at level 160	**(b)** thresholding by Otsu (level = 127)

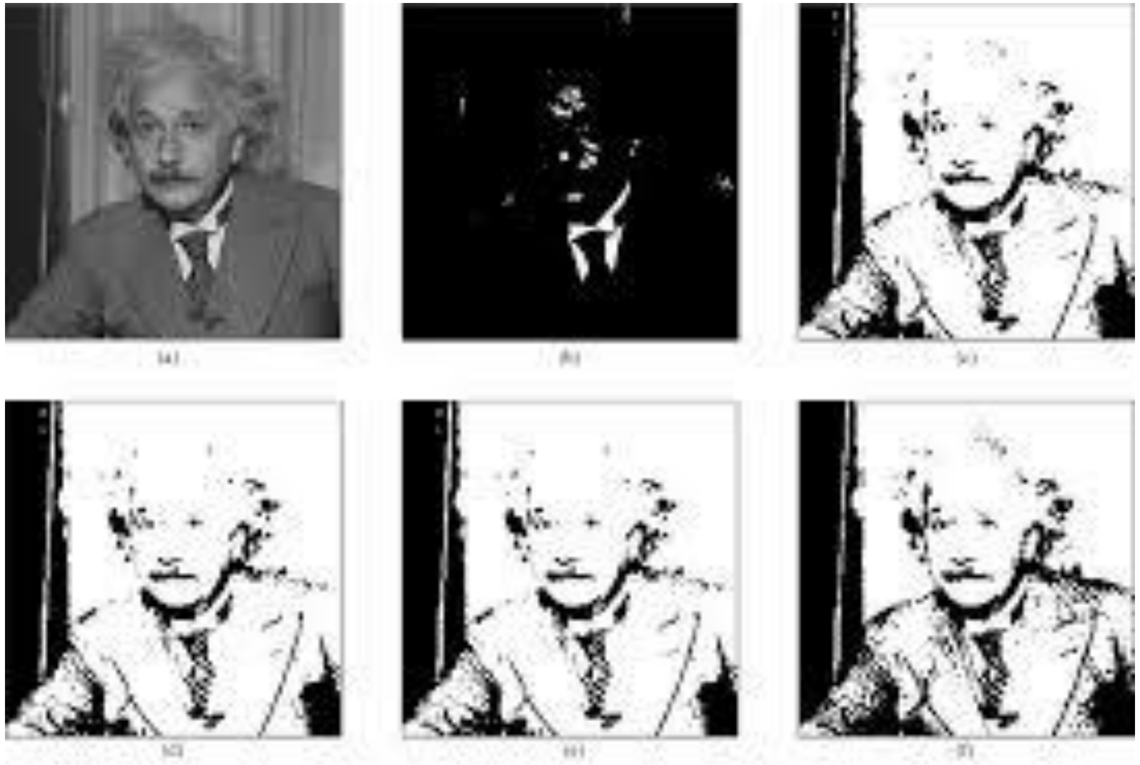
Thresholding an image of a walking subject

(a) walking subject

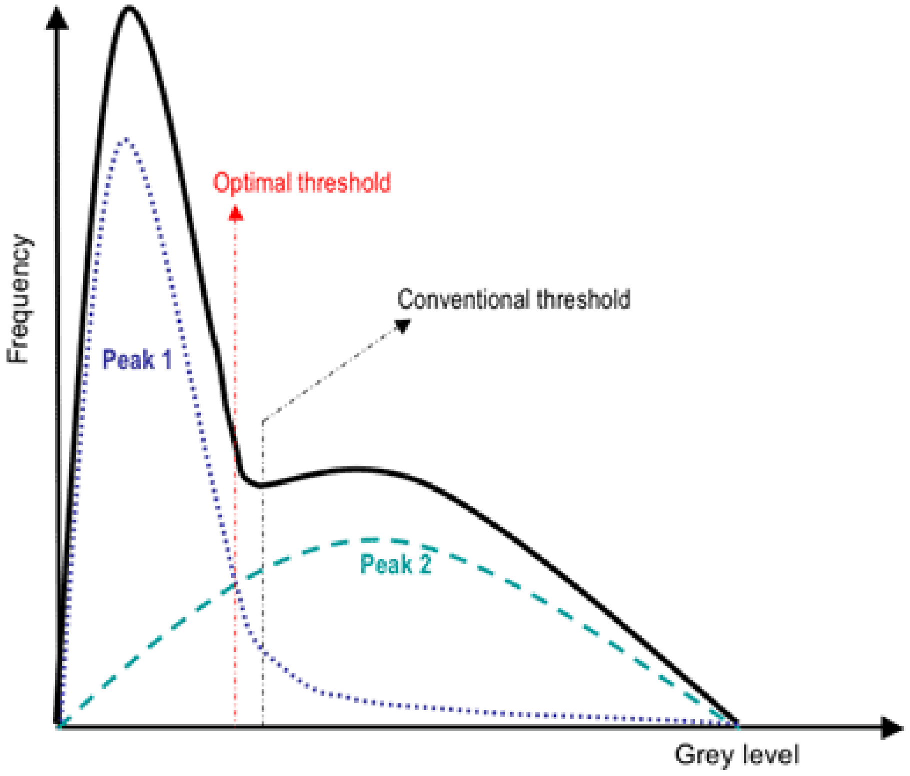
(b) automatic thresholding by Otsu

Advanced thresholding

Entropic thresholding (2010)



Optimal thresholding



http://opticalengineering.spiedigitallibrary.org/article.aspx?articleid=1096546; https://www.cs.auckland.ac.nz/courses/compsci773s1c/lectures/ImageProcessing-html/topic3.htm