

Lecture 2:

Image Enhancement

Why Enhancement?

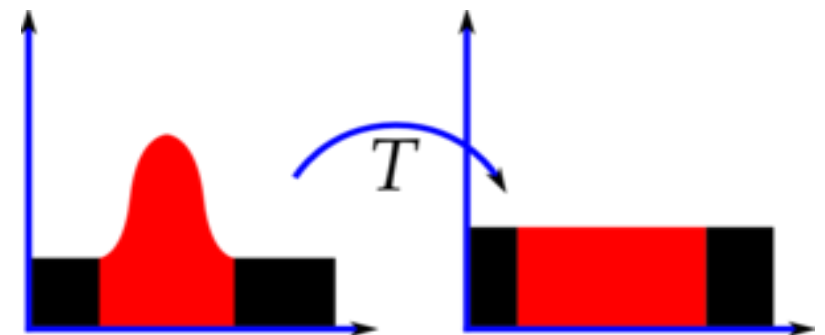
- ❑ Images may suffer from the following degradations:
 - **Poor contrast** due to poor illumination or finite sensitivity of the imaging device
 - **Electronic sensor noise** or atmospheric disturbances leading to broadband noise
 - Aliasing effects due to **inadequate sampling**
 - Finite aperture effects or motion leading to spatial

Cont..

- ❑ There are various and simple algorithms for image enhancement based on lookup tables
 - *Contrast enhancement*
- ❑ Other algorithms also work with simple linear filtering methods
 - *Noise removal*

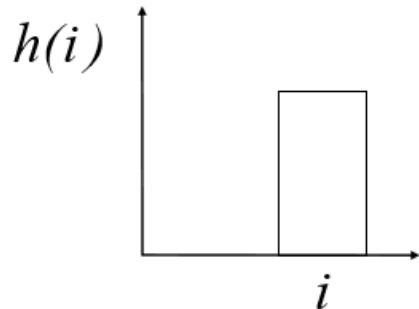
Histogram equalisation

- ❑ Equalization increases the global **contrast** of many images, especially when the usable **data** of the image is represented by close contrast values.
- ❑ Through this adjustment, the **intensities** can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast.
- ❑ Histogram equalization accomplishes this by effectively **spreading out the most frequent intensity values**.
 - ✓ The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better views of **bone** structure in **x-ray** images



Histogram equalisation

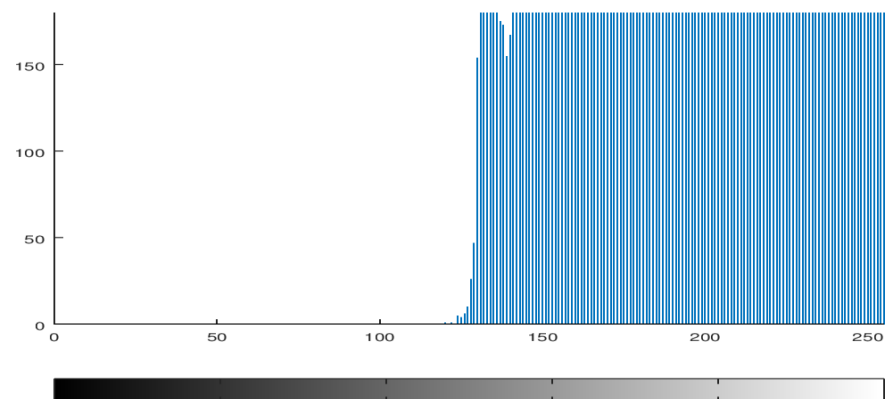
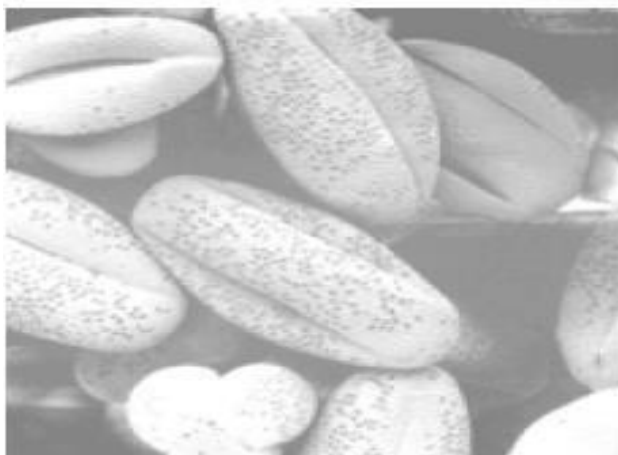
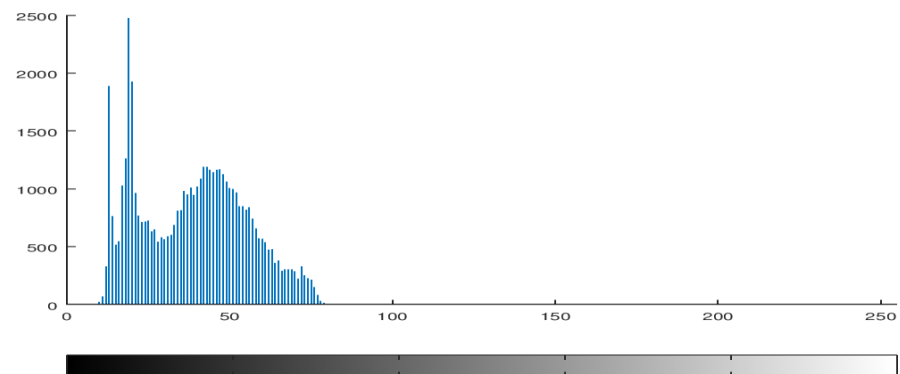
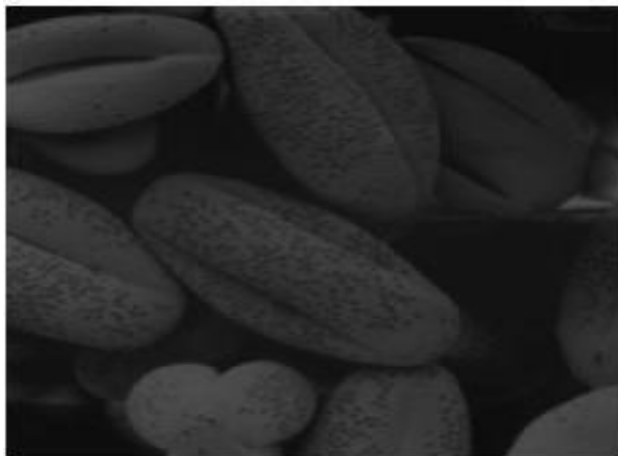
- ❑ In an image of **low contrast**, the image has grey levels **concentrated** in a **narrow band**
 - *The grey-levels are not too dark or too bright but in the middle. And it covers only few grey-level intensity range*
- ❑ Define the grey-level histogram of an image $h(i)$ where :
 - $h(i)$ =number of pixels with grey level = i
- ❑ Graphically, the histogram for a specific grey-level will be:



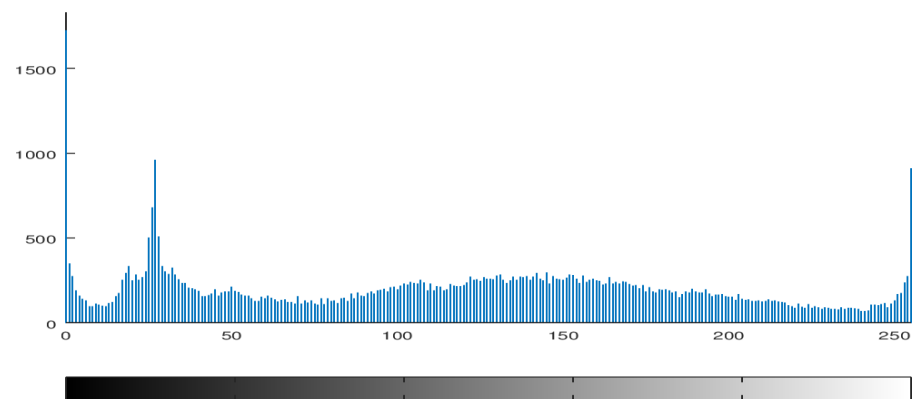
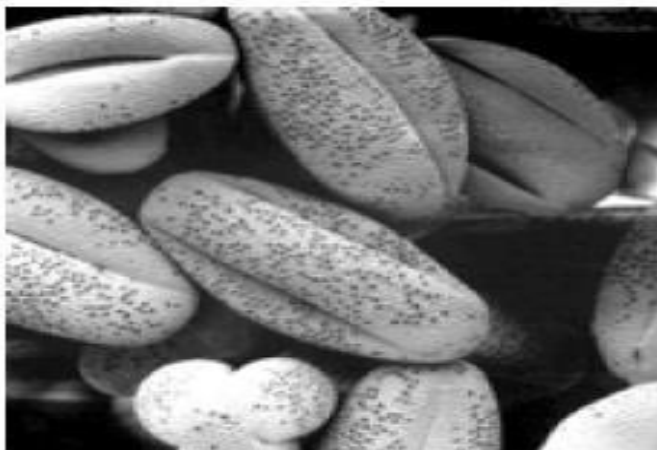
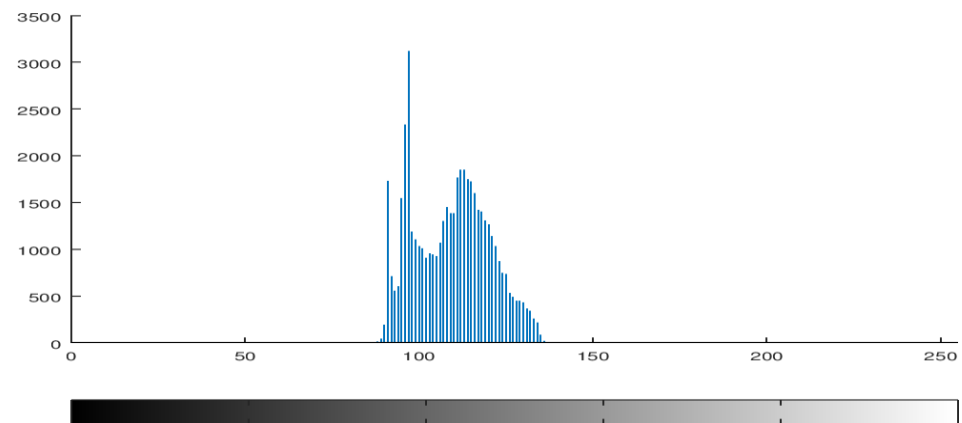
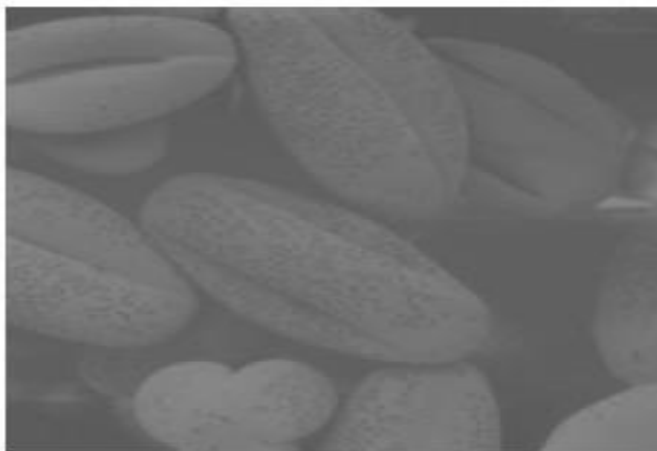
Darker

vs

Bright Image



Low vs High Contrast Image



Histogram equalisation



Original



Black/White

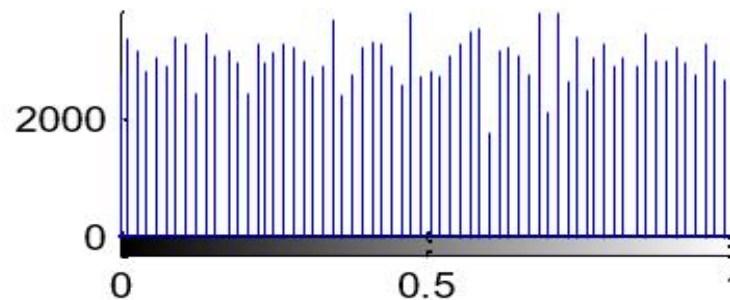
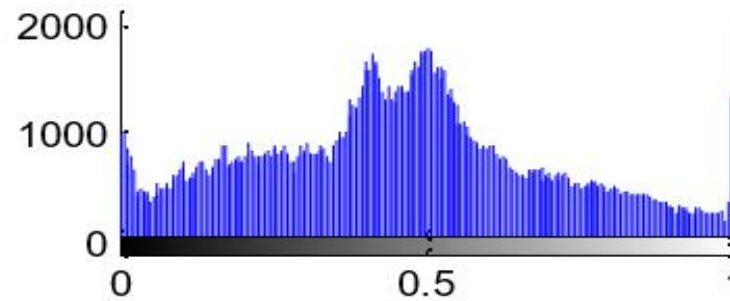


Grey Level



Histogram Equalized

Histogram Equalized Image

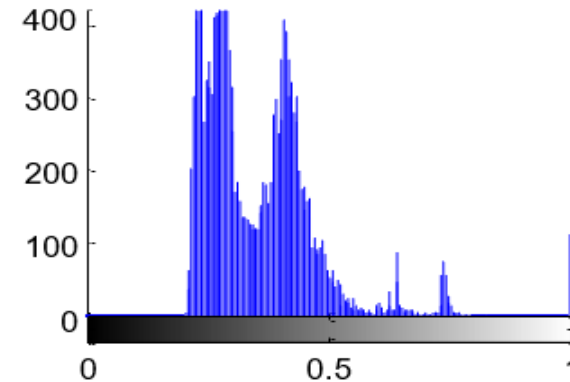


Improving a Low Contrast Image

Original



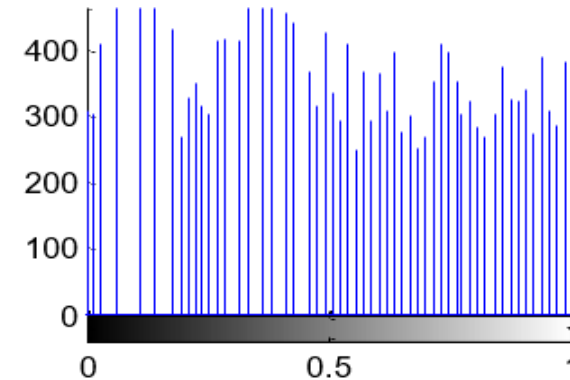
Histogram of Low Contrast Image



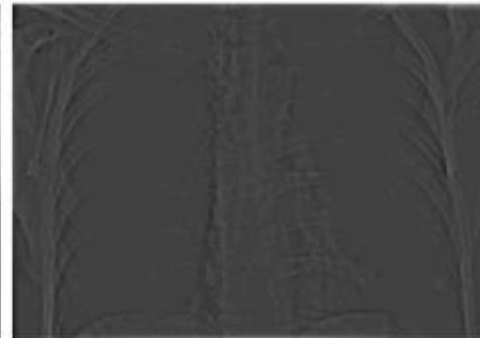
Histogram Equalized



Histogram of Equalized Image



Histogram equalisation



Gaussian highpass
filtering

High-frequency
emphasis filtering



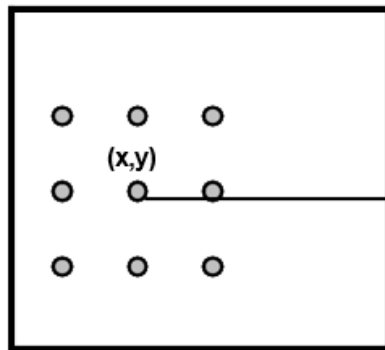
Histogram
Equalisation

Image Filtering

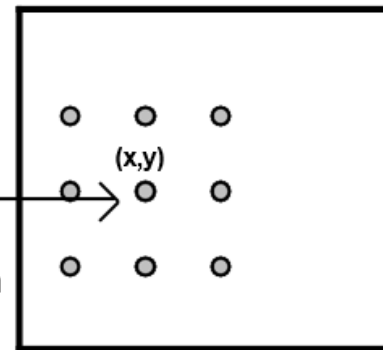
- Simple image operators can be classified as:
 - **'pointwise'** which changes a pixel independent of the others;
 - **'neighbourhood'** (filtering) which changes the pixel value by consulting some or all of its neighbours
- *Histogram equalisation is a pointwise operation*
- More general filtering operations use neighbourhoods of pixels

Image Filtering

Input image

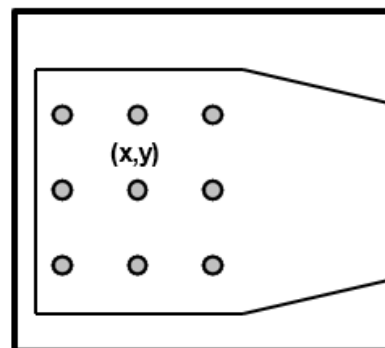


Output image

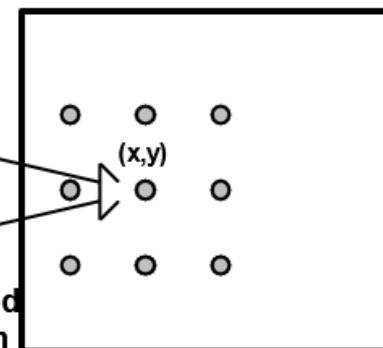


pointwise
transformation

Input image

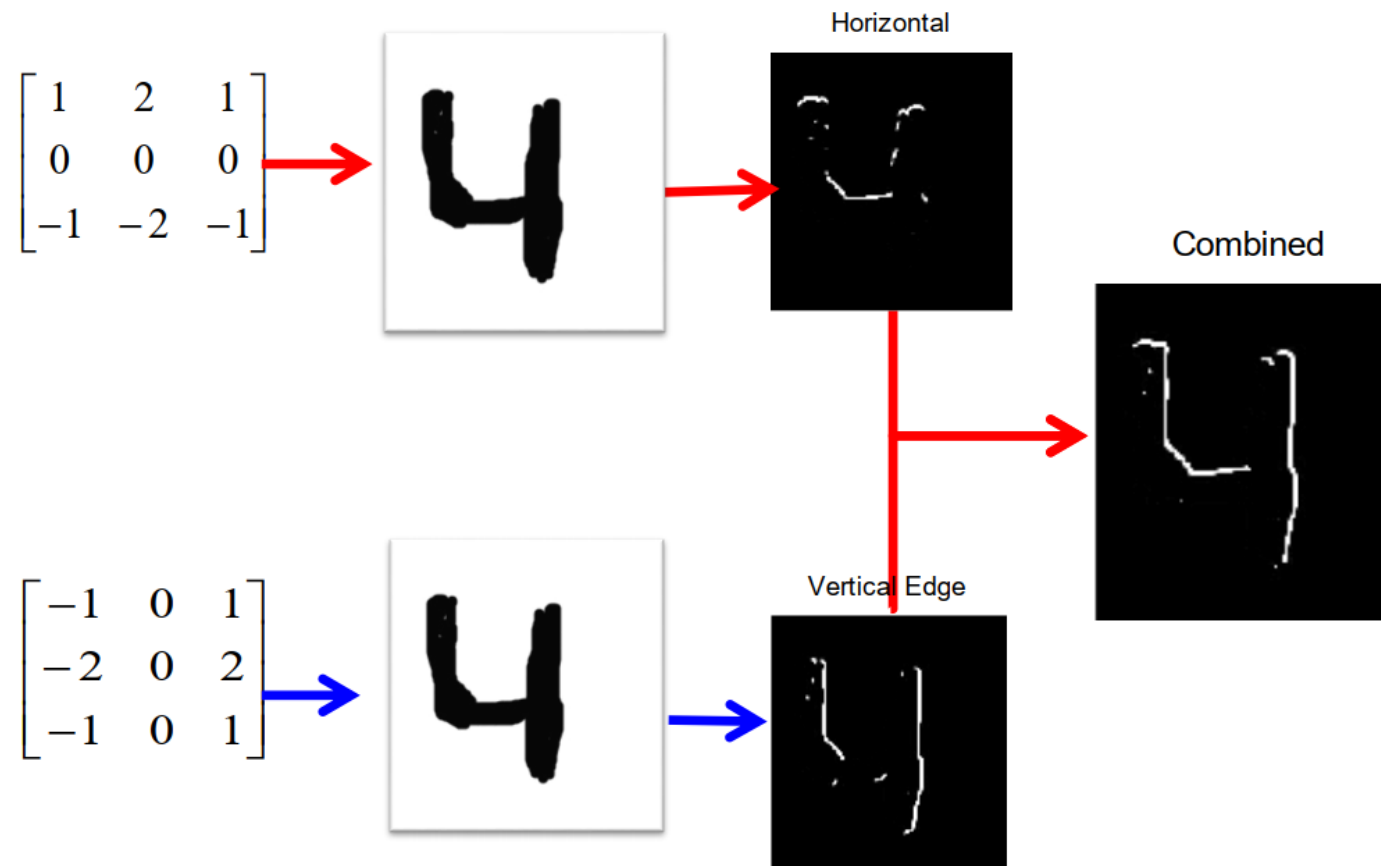


Output image



neighbourhood
transformation

Edge Detection



Conclusion

- ❑ We have looked at basic (low level) image processing operations
 - Enhancement
 - Filtering
- ❑ These are usually important pre-processing steps carried out in computer vision systems



The End