Lecture 6-2 Histogram 2 (chapter 3.6)

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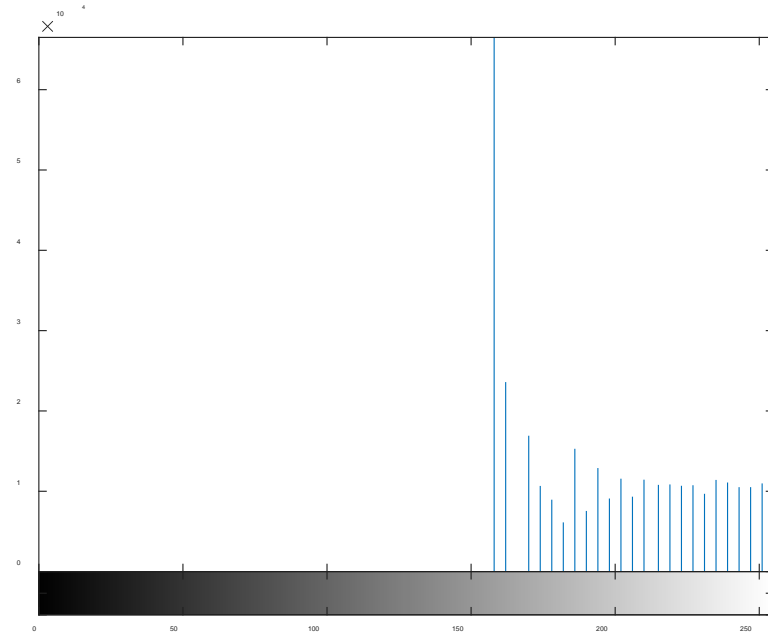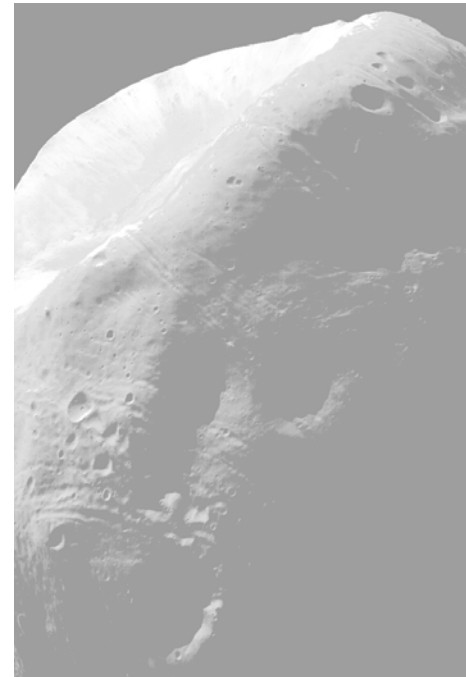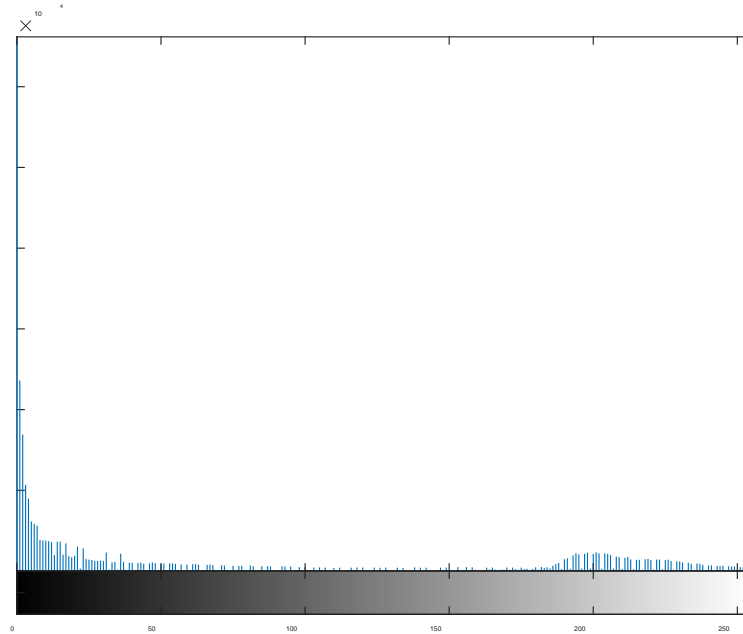
Outline

➢Adaptive Histogram Equalization (AHE)

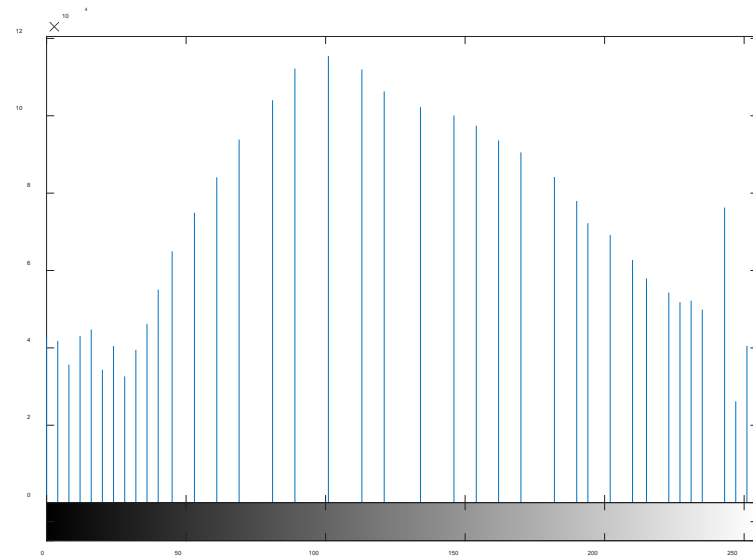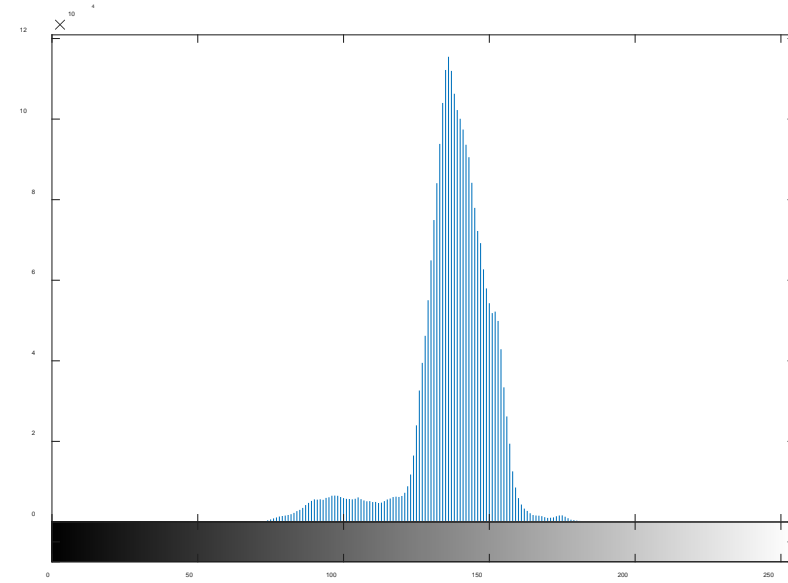➢Contrast Limited Adaptive Histogram Equalization (CLAHE)

Key problem of HE

$$s = T(r) = (L-1) \int_0^r p_r(w)\,dw = (L-1) \sum_{j=0}^{k} p_r(r_j) = (L-1) \sum_{j=0}^{k} \frac{n_j}{MN} = \frac{L-1}{MN} \sum_{j=0}^{k} n_j$$

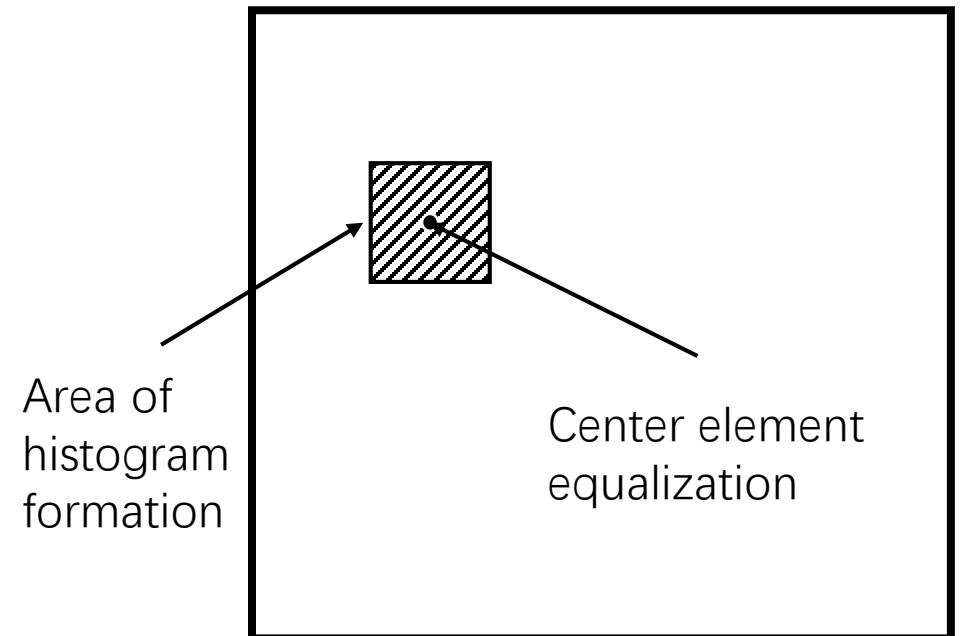# Key problem of HE

Naïve Adaptive Histogram Equalization

➢ Traverse every pixel with a $W * W$ patch, process histogram equalization within each patch and update the center pixel.

➢ Advantage: better uniform distributed histogram.

➢ Disadvantage： high complexity

$O(W * W + L)$ within each patch

$O(M * N * (W * W + L))$ for whole image

Area of histogram formation

Center element equalization

Naïve Adaptive Histogram Equalization

➢For faster processing AHE, it is proposed to update a center patch of size $M * M$ instead of just the center pixel in each HE in each within the $W * W$ patch HE.

➢Pixels near the image boundary have to be treated specially, This can be solved by extending the image by mirroring pixel lines and columns with respect to the image boundary.

$W * W$

$M * M$
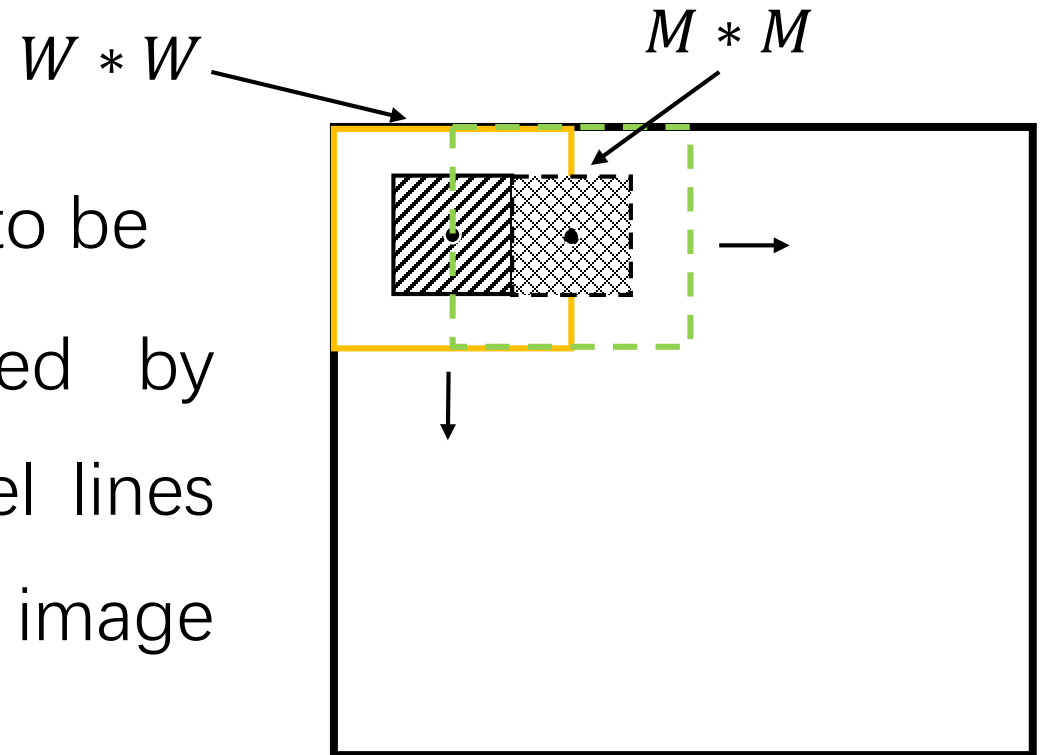
Effect of AHE
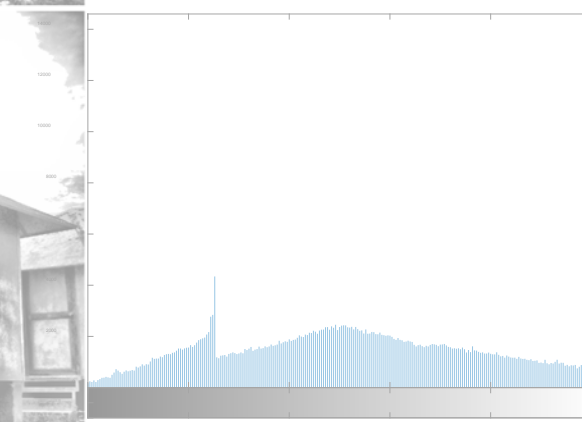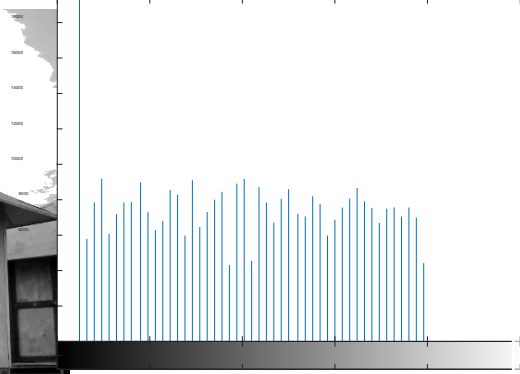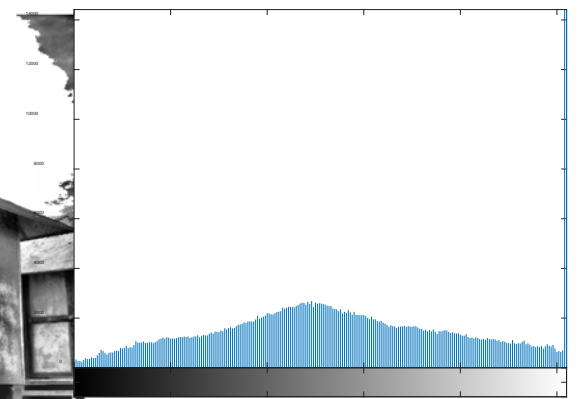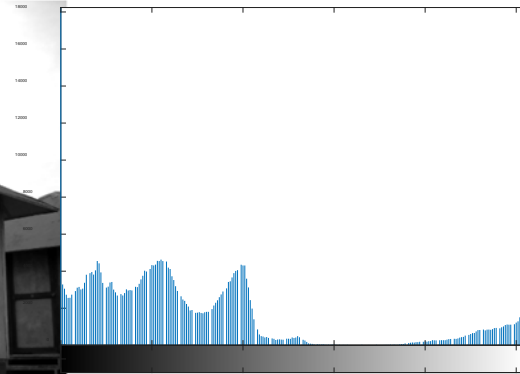
Contrast Limited Adaptive Histogram Equalization (CLAHE)

➢CLAHE differs from naïve AHE in its contrast limiting.

➢CLAHE was developed to prevent the over amplification of noise that AHE can give rise to.

➢This feature can also be applied to global histogram equalization, giving rise to contrast limited histogram equalization.
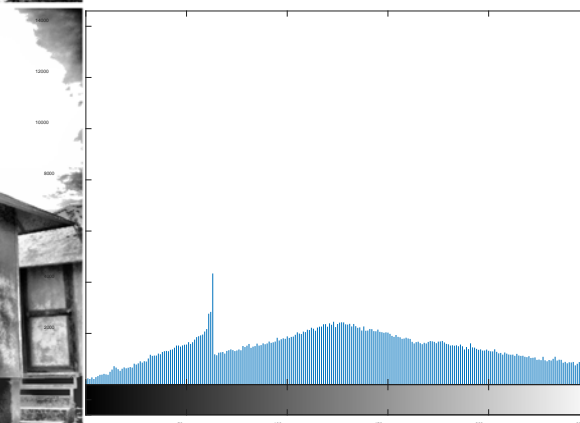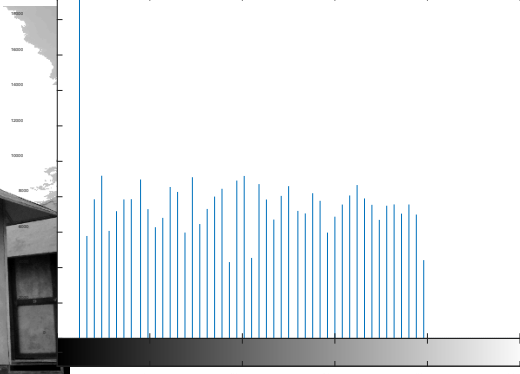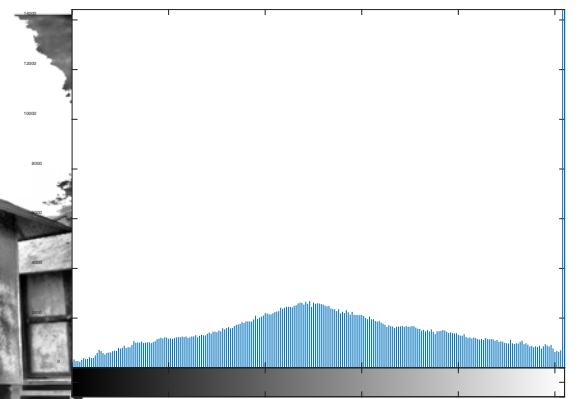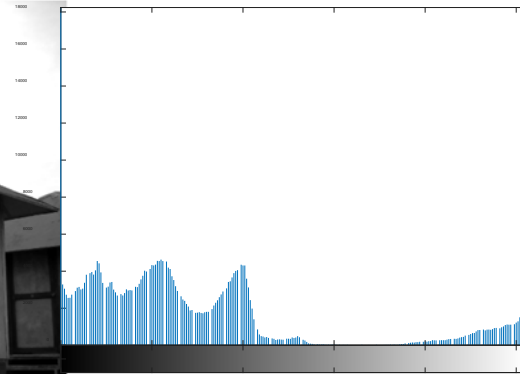
CLAHE

➢ CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF.

➢ This limits the slope of the CDF and therefore of the transformation function.

➢ The so-called clip limit depends on the normalization of the histogram and thereby on the size of the neighbourhood region.
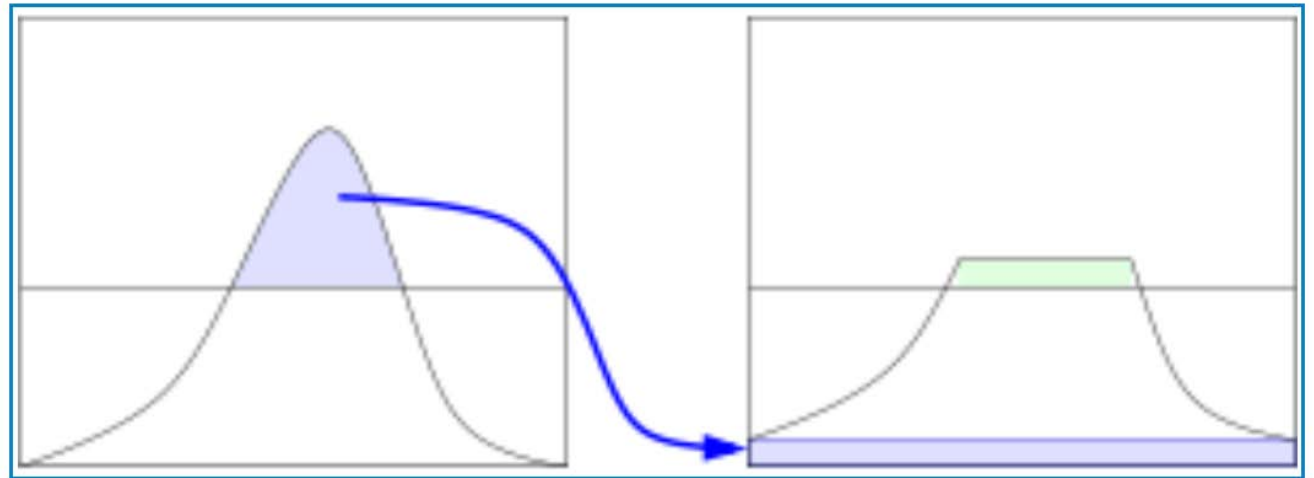
Effect of CAHE

Take home message

- Key idea: AHE&CLAHE was developed to prevent the over amplification of noise.