Computer Vision

10: Image Equalization

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Histogram Equalization

Image Equalization

Histogram Equalization

- **Histograms** capture the intensity distribution.
- **Low contrast** (differences/variations) images typically have the distribution clustered in a narrow range.
- **Equalization:** Changing the probability distribution of intensities in original image to roughly an uniform distribution.

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$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j)$$

$$\text{where, } k = 0, 1, 2, \ldots, L-1$$

Image Equalization

Histogram Equalization

r_k	n_k	$p_r(r_k) = n_k / MN$
$r_0 = 0$	790	0.19
$r_1 = 1$	1023	0.25
$r_2 = 2$	850	0.21
$r_3 = 3$	656	0.16
$r_4 = 4$	329	0.08
$r_5 = 5$	245	0.06
$r_6 = 6$	122	0.03
$r_7 = 7$	81	0.02

$s_0 = 1.33 \rightarrow 1$ $\quad$ $s_2 = 4.55 \rightarrow 5$

$s_1 = 3.08 \rightarrow 3$ $\quad$ $s_3 = 5.67 \rightarrow 6$

$s_4 = 6.23 \rightarrow 6$ $\quad$ $s_6 = 6.86 \rightarrow 7$

$s_5 = 6.65 \rightarrow 7$ $\quad$ $s_7 = 7.00 \rightarrow 7$

Image Equalization

Histogram Equalization

- Considered the best method for enhancement.
- No information is lost in the process but yields better quality images.
- **Equalization:** Changing the probability distribution of intensities in original image to roughly an uniform distribution.

Image Equalization

Histogram Equalization

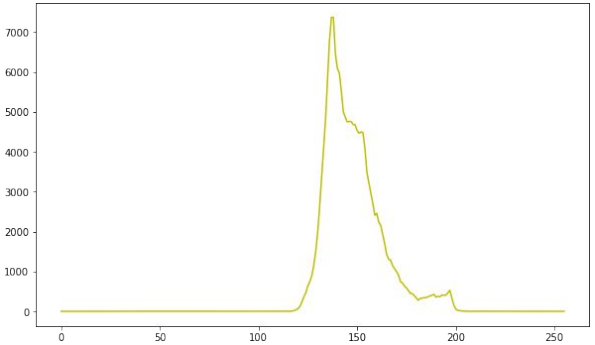
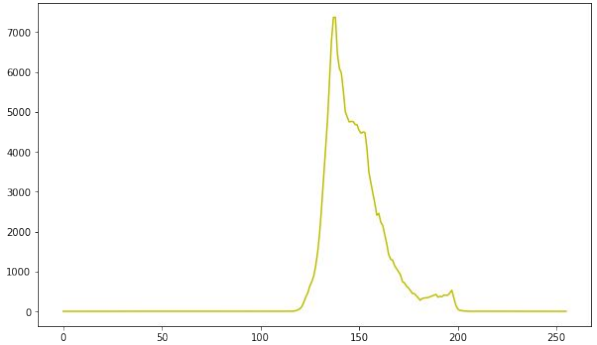
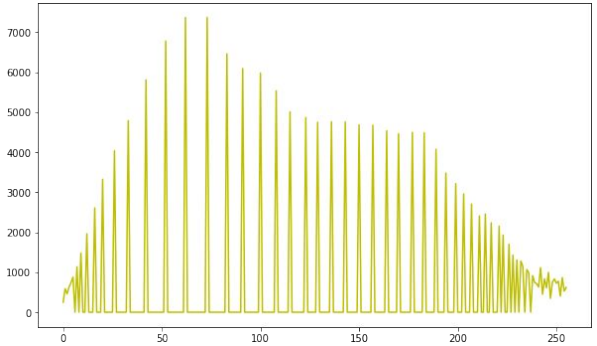


Image Equalization

Histogram Equalization





CLAHE
Contrast Limited Adaptive Histogram Equalization

Image Equalization

CLAHE: Contrast Limited Adaptive Histogram Equalization

- In some cases, contrast might be over amplified.
- To avoid such situation, block-wise (tiles) enhancement is applied instead of entire image.
- Tile enhancement are then further enhanced using bilinear interpolation for smooth output.

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- CLAHE can also be applied on color images.
- For HSV - apply CLAHE on V channel.
- For LAB - apply CLAHE on L channel.

Image Equalization

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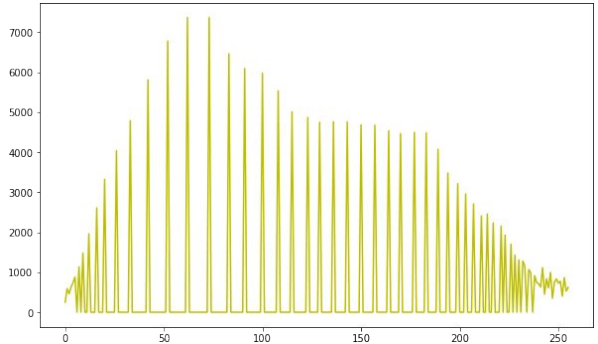

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