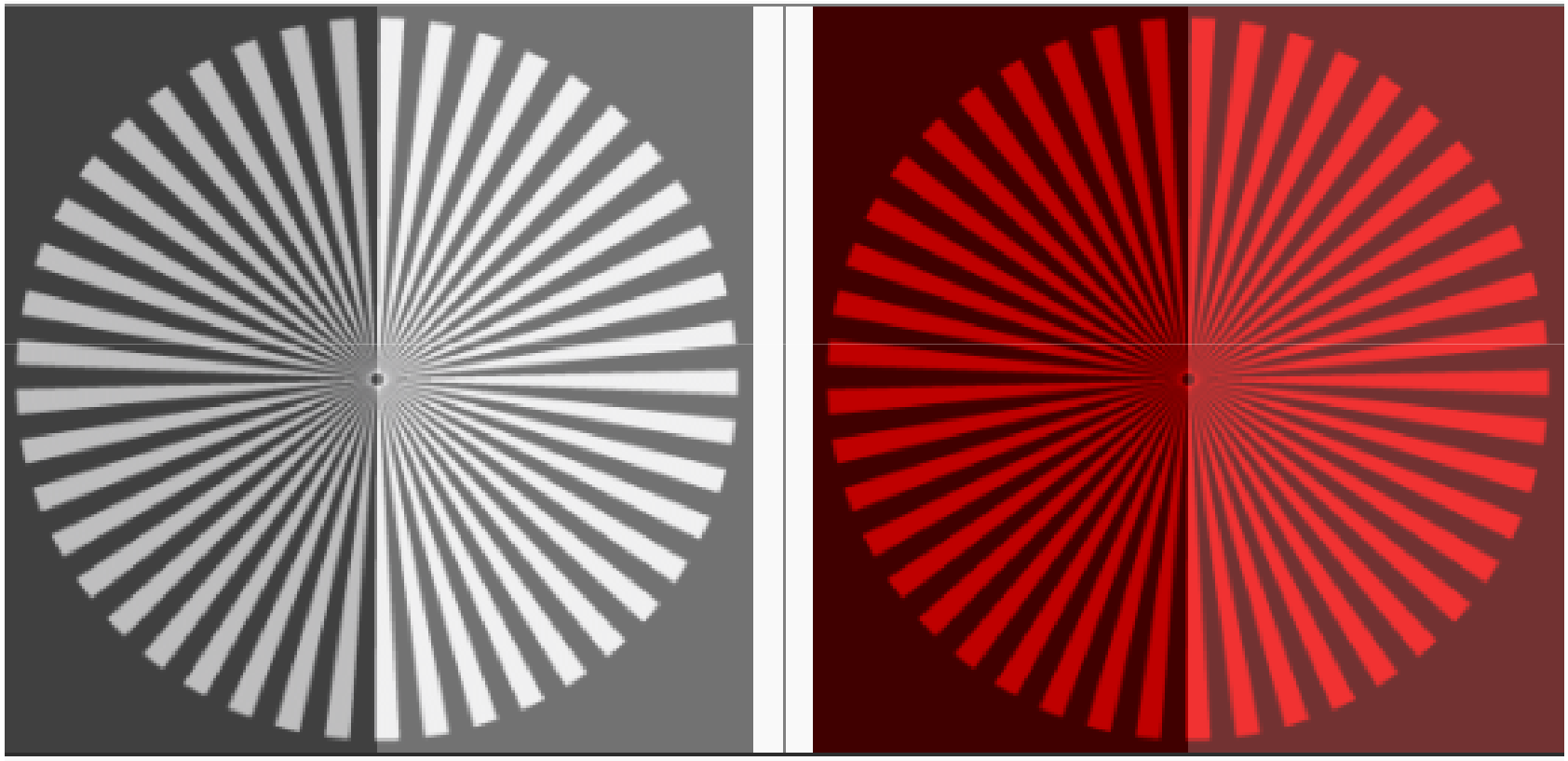
Image Brightness

- Brightness of a grayscale image is the average intensity of all pixels in images.

$$B(I) = \frac{1}{N * M} \sum_{v=0}^{N-1} \sum_{u}^{M-1} I(u, v)$$

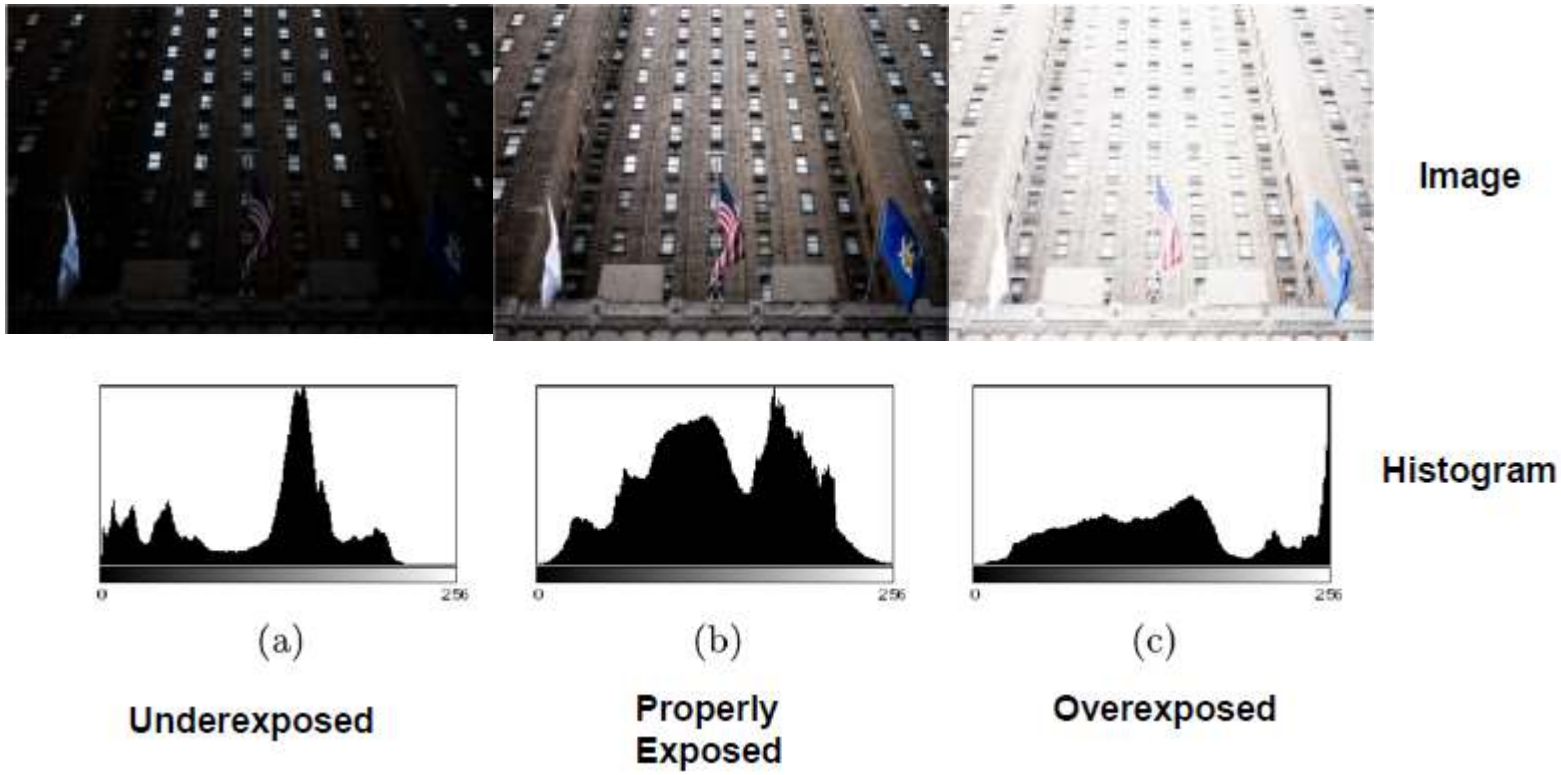
Brightness



Increase Brightness

Detecting bad exposure using histograms

- Exposure: Related to how dark or light a digital image appears?



Contrast

- Contrast indicates how easily object in the image can be indicated.
- High contrast image: many distinct intensity values.
- Low contrast images: Image uses few intensity values.

Contrast

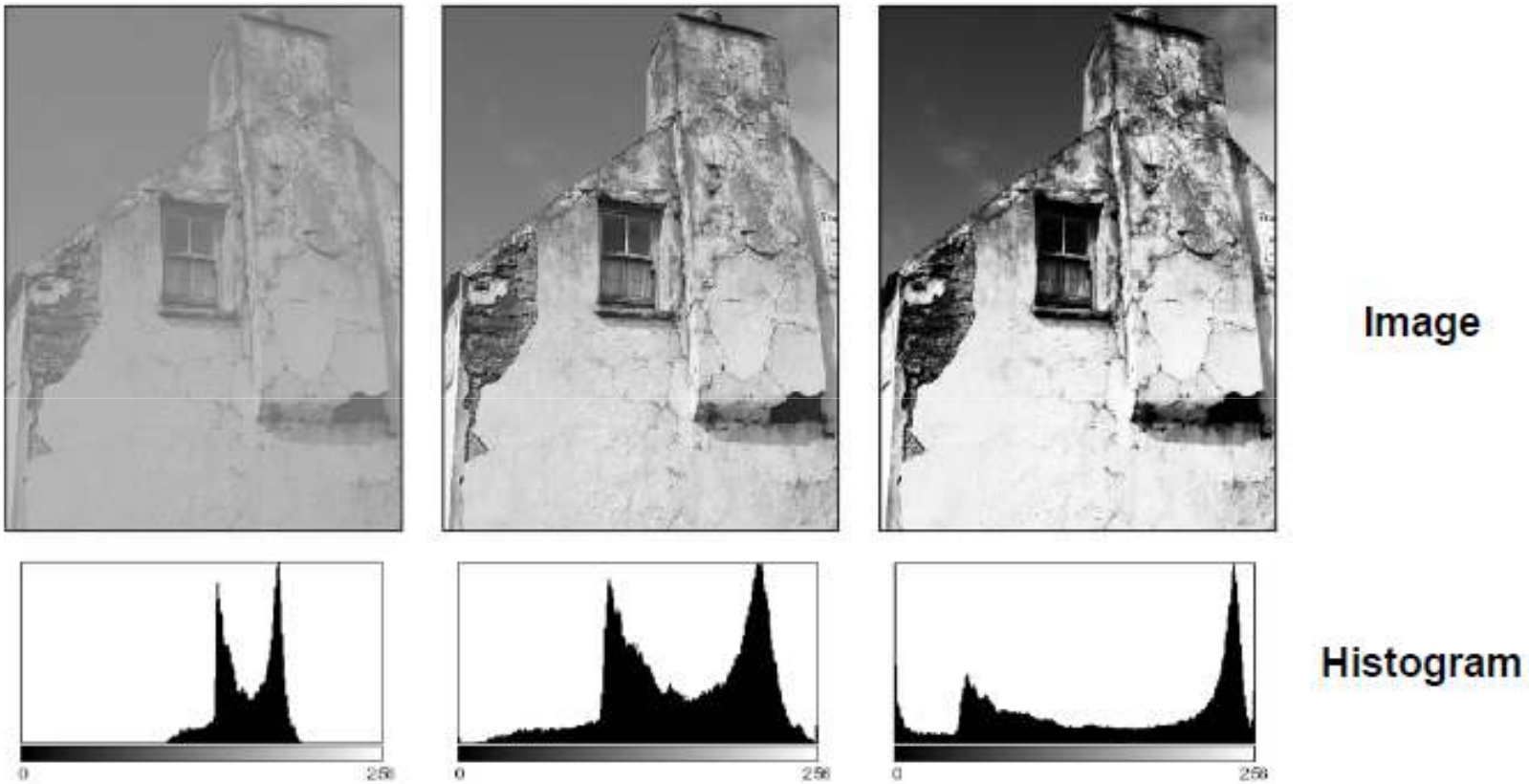
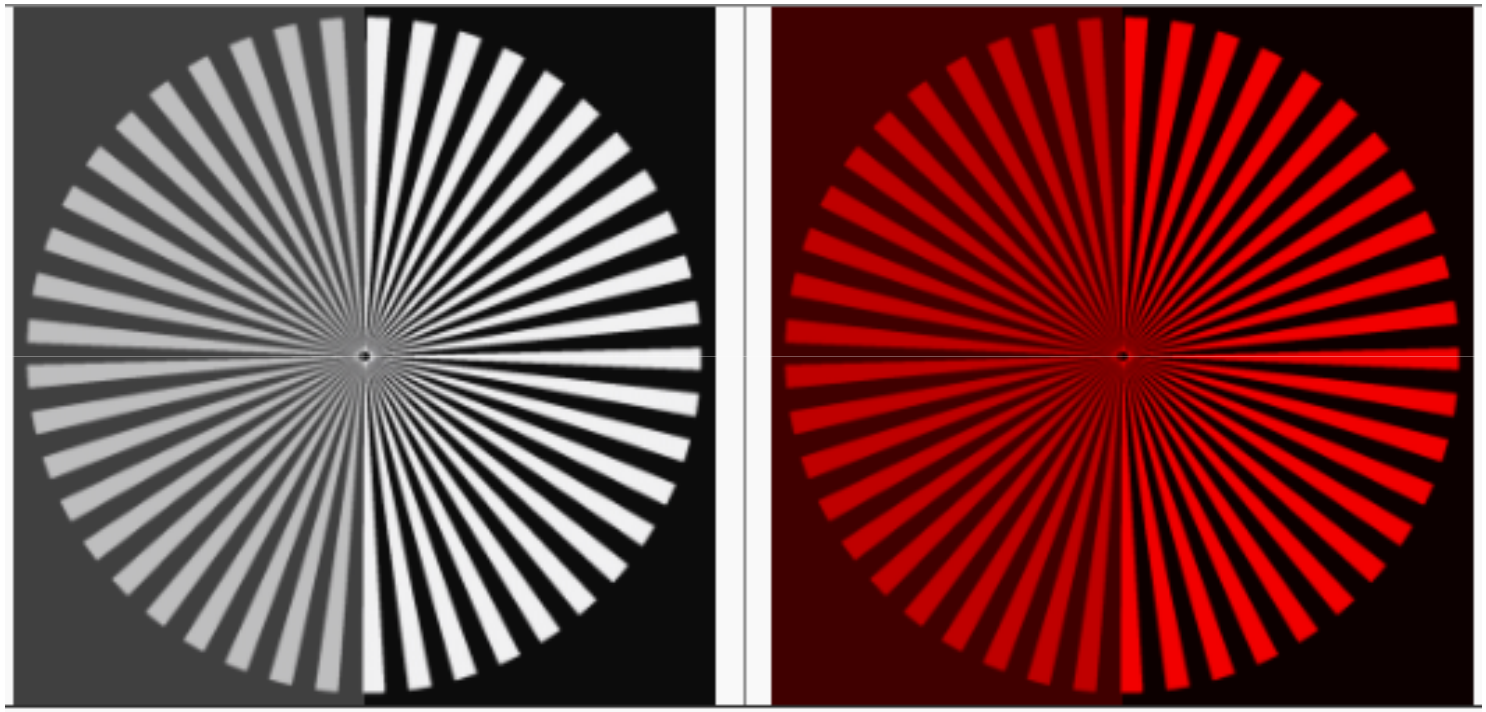


Image
Histogram
0
256
0
256
0
256
(a)
Low contrast
(b)
Normal contrast
(c)
High contrast

Contrast



Increase Contrast

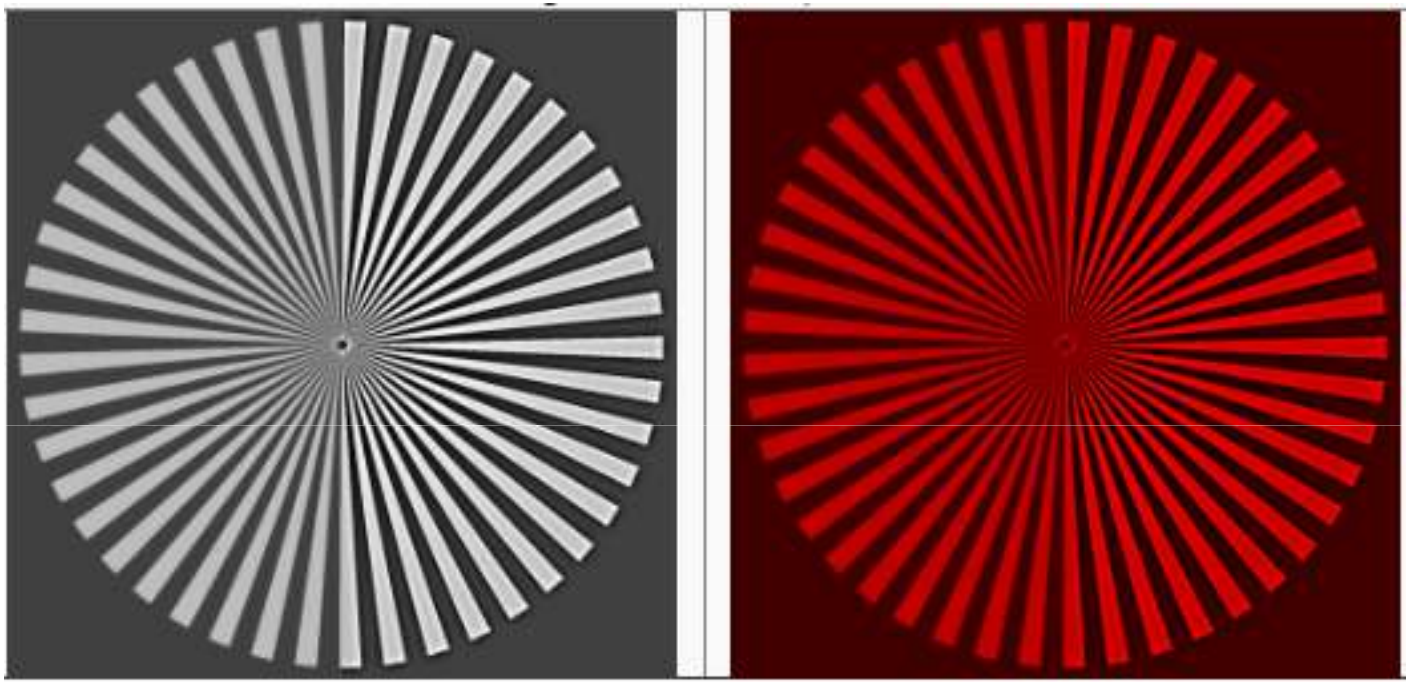
Contrast Equation?

- Michalson's equation for contrast:

$$C_M(I) = \frac{Max(I) - Min(I)}{Max(I) + Min(I)}$$

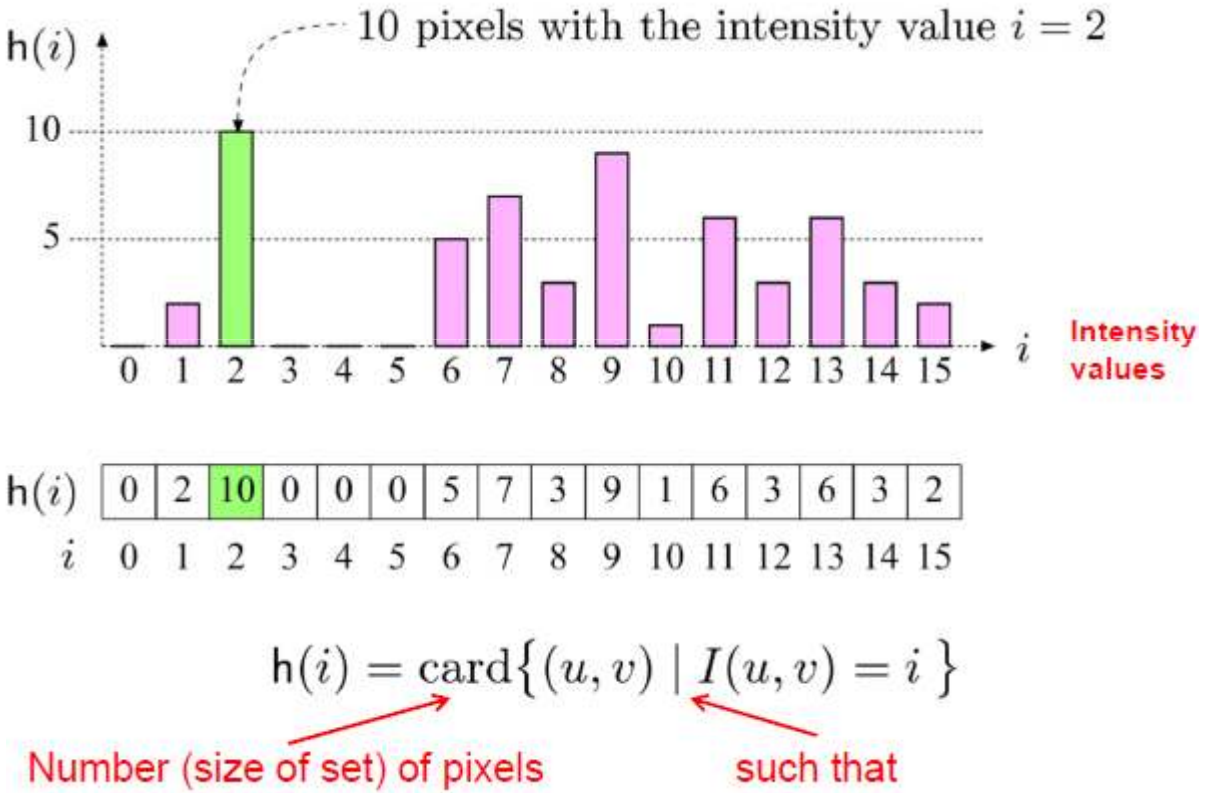
- This equation works well for simple images with two luminance(i.e. uniform foreground and background).
- Does not work well for complex scenes with many luminance of if min and max values intensities are small.

Sharpness



Sharpness can be defined as edge contrast, that is, the contrast along edges in a photo. When we increase sharpness, we increase the contrast only along/near edges in the photo while leaving smooth areas of the image alone.

Histograms



Can you write the pseudocode for obtaining an image histogram ?

Arithmetic Operation

Arithmetic operations between two images f(x,y) and g(x,y) are denoted as:

$s(x,y)=f(x,y)+g(x,y)$

$d(x,y)= f(x,y)-g(x,y)$

$p(x,y)= f(x,y) \cdot g(x,y)$

$v(x,y)= f(x,y)/g(x,y)$

These are elementwise operations meaning they are performed between corresponding pixels pairs in f and g.

Addition Operator

s(x,y)=f(x,y)+g(x,y)

$$f(x,y)=\begin{bmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{bmatrix}$$

$$g(x,y)=\begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}$$

$$s(x,y)=\begin{bmatrix} f_{11}+g_{11} & f_{12}+g_{12} \\ f_{21}+g_{21} & f_{22}+g_{22} \end{bmatrix}$$

Addition Operator

Useful for combining information from two images.

$$O(x,y) = \alpha * I_1(x,y) + (1-\alpha) I_2(x,y)$$

$$0 \le \alpha \le 1$$

O(x,y)

$I_1(x,y)$

$I_2(x,y)$

Image addition for noise reduction

g(x,y) is a corrupted image formed by addition of noise.

g(x,y)=f(x,y)+η(x,y), where at every pair of coordinates (x,y) the noise is uncorrelated and has zero average value.

η(x,y) has a mean of zero and standard deviation of σ_η

Image addition for noise reduction

We can use a set of nosy images of the same scene to obtain an image with noise reduction.

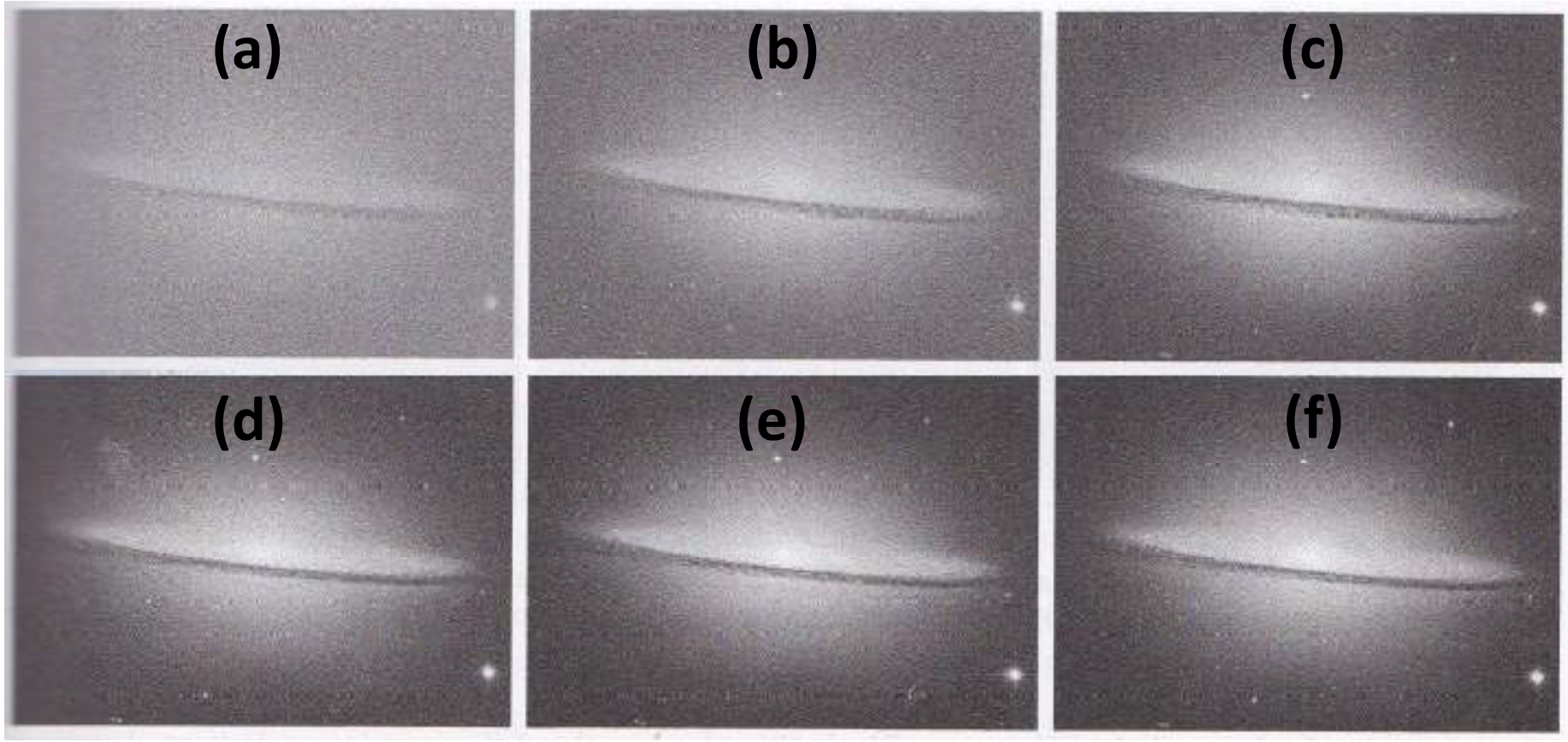
$$\bar{g}(x,y) = \frac{1}{K}\sum_{i=1}^{K} g_i(x,y)$$

$$E\left[\bar{g}(x,y)\right] = f(x,y)$$

$$\sigma^2_{\bar{g}(x,y)} = \frac{1}{K}\sigma^2_{\eta(x,y)}$$

$$\sigma_{\bar{g}(x,y)} = \frac{1}{\sqrt{K}}\sigma_{\eta(x,y)}$$

Image addition for noise reduction

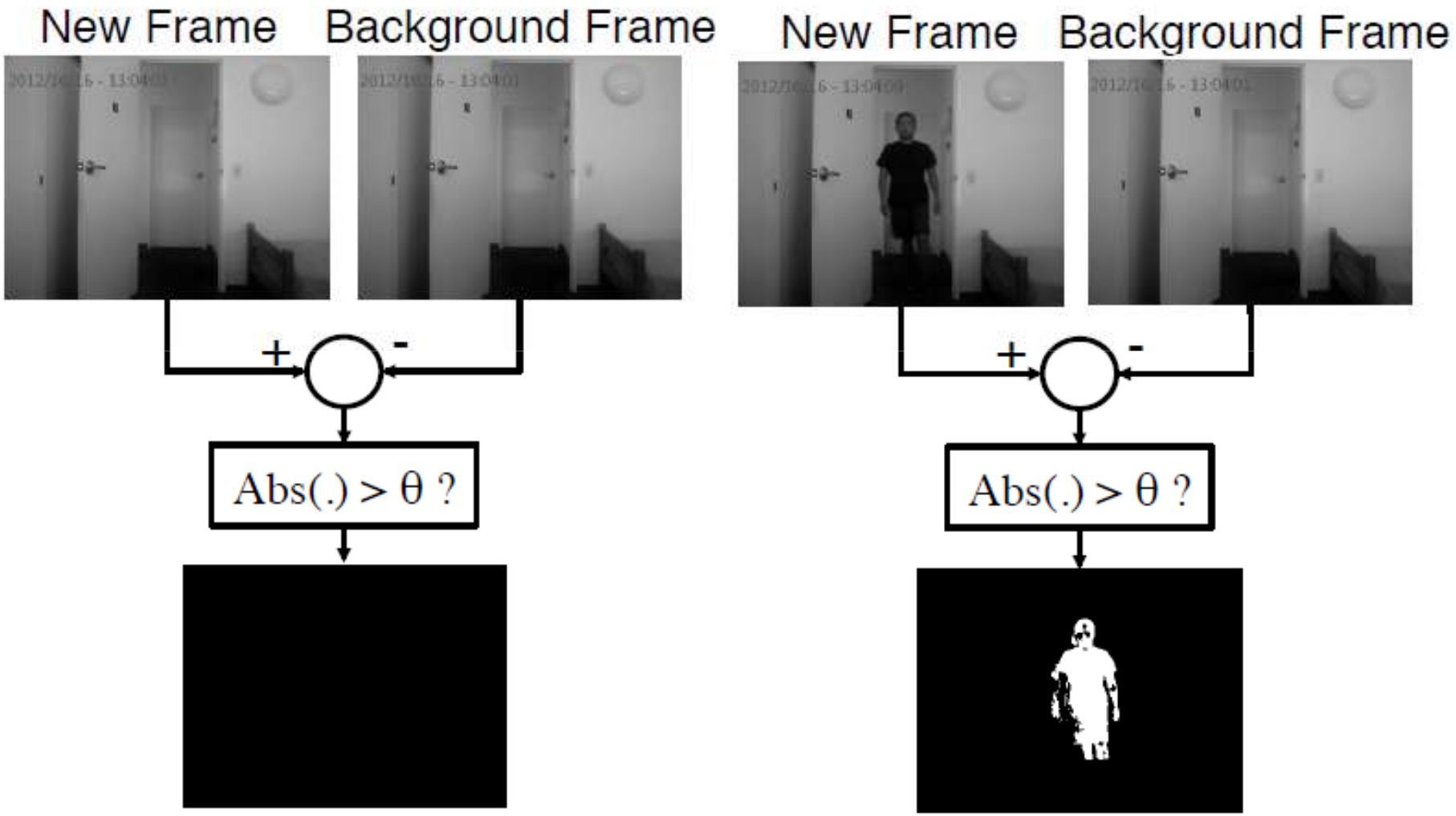


(a) Sample noisy image of Sombrero Galaxy
(b)-(f) Result of averaging 10,50,100,500, and 1,000 noisy images, respectively.

Comparing images using subtraction

- Subtraction operator can be used to identify changes between two consecutives frame in videos

Comparing images using subtraction



Can you write the pseudocode for this system?