Image Enhancement

Spatial & Frequency Domains

- There are two broad categories of image enhancement techniques
- Spatial domain techniques
  - Direct manipulation of image pixels (intensity values)
- Frequency domain techniques
  - Manipulation of Fourier transform or wavelet transform of an image

Unsharp masking (USM)

- The "unsharp" of the name derives from the fact that the technique uses a blurred, or "unsharp", negative image to create a mask of the original image.
- The unsharped mask is then combined with the positive (original) image, creating an image that is less blurry than the original.
- The resulting image, although clearer, may be a less accurate representation of the image's subject.
- In the context of signal processing, an unsharp mask is generally a linear or nonlinear filter that amplifies the high-frequency components of a signal.

Unsharp masking

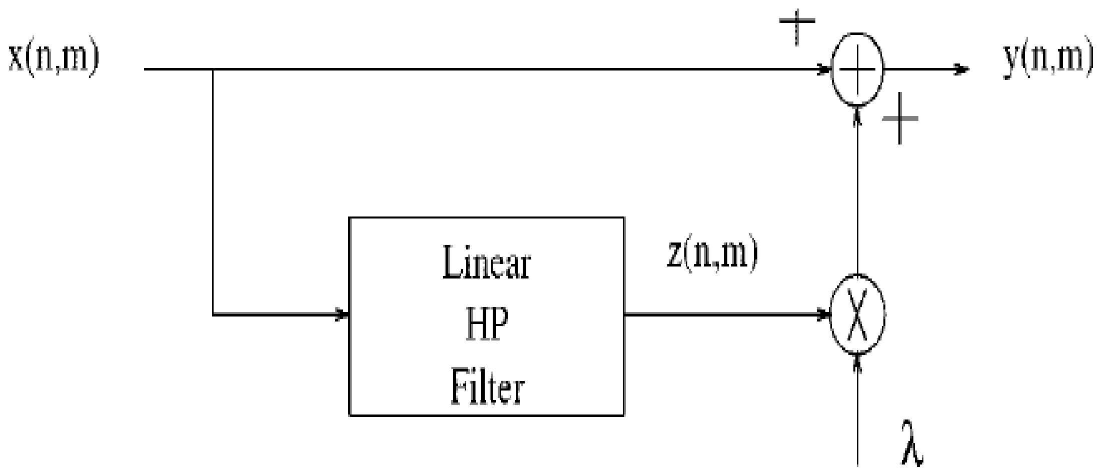
- Want to emphasize high frequency contents of an image.

$$y(n, m) = x(n, m) + \lambda z(n, m)$$

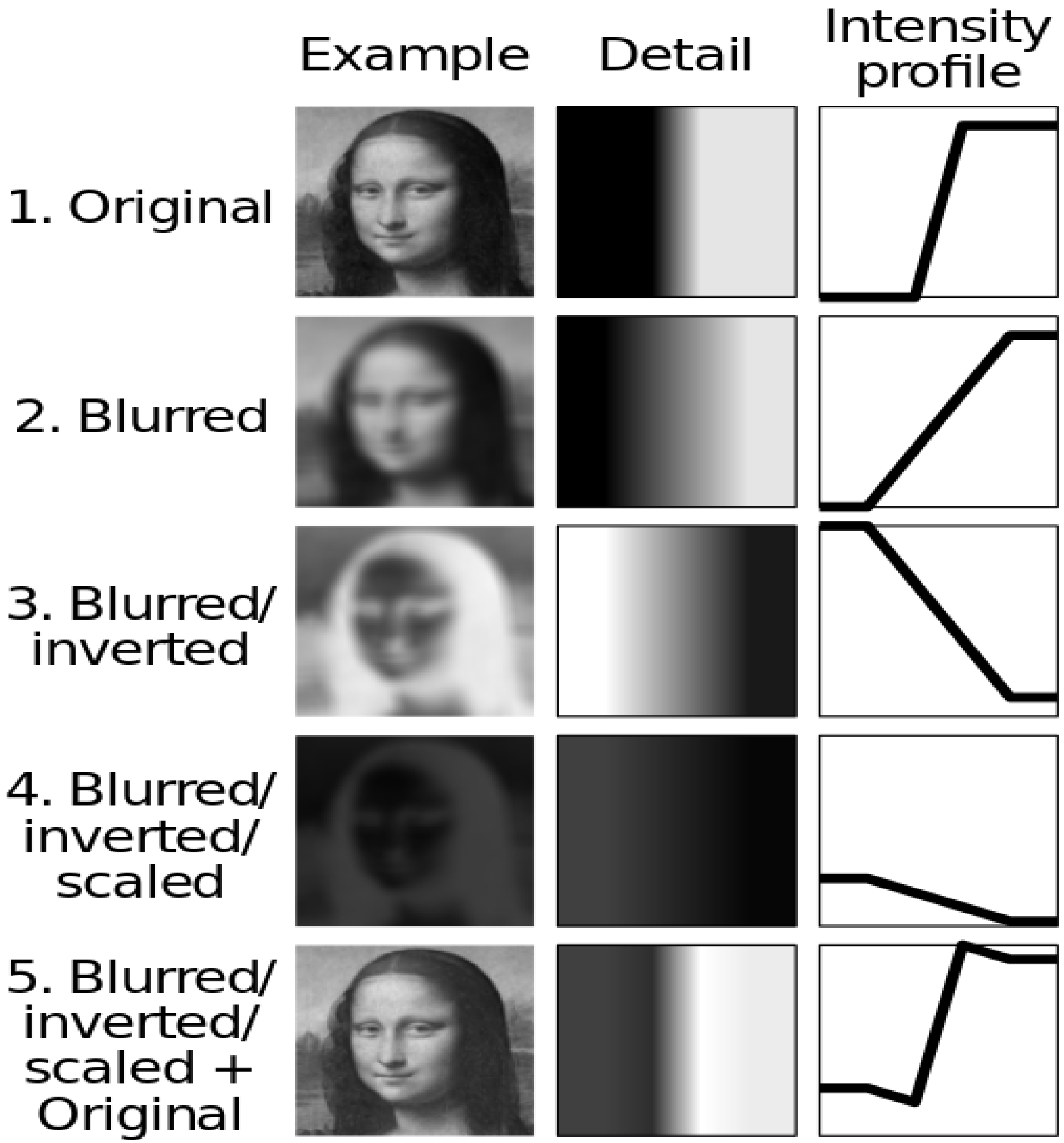
- Z(n,m) is a high pass filtered version of image
- λ controls the level of contrast enhancement
- Disadvantages:

  Noise in smooth regions

  Overshoot artifacts



Unsharp masking



Homomorphic Filtering

- We can view an image f(x,y) as a product of two components:

$$f(x, y) = i(x, y) \cdot r(x, y)$$

$$0 < i(x, y) < \infty$$

$$0 < r(x, y) < 1$$

i(x,y): illumination.

It is determined by the illumination source.

r(x,y): reflectance (or transmissivity).

It is determined by the characteristics of imaged objects.

Homomorphic Filtering

- In some images, the quality of the image has reduced because of non-uniform illumination.
- Homomorphic filtering can be used to perform illumination correction.

$$f(x, y) = i(x, y) \cdot r(x, y)$$

- The above equation cannot be used directly in order to operate separately on the frequency components of illumination and reflectance.

Homomorphic Filtering

- By separating the illumination and reflectance components, homomorphic filter can then operate on them separately.
- Illumination component of an image generally has slow variations, while the reflectance component vary abruptly.
- By removing the low frequencies (highpass filtering) the effects of illumination can be removed .

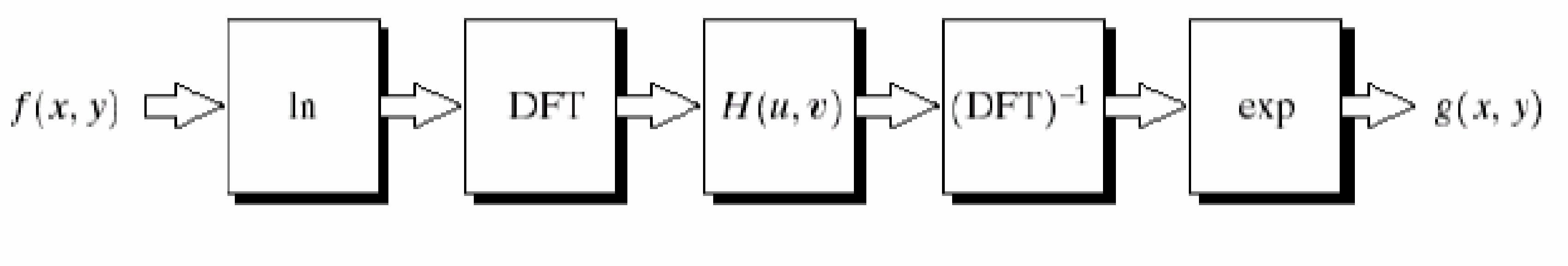
Homomorphic Filtering

DFT : $Z(u,v) = F_i(u,v) + F_r(u,v)$

H(u,v) : $S(u,v) = H(u,v)Z(u,v)$

(DFT)$^{-1}$: $s(x,y) = i'(x,y) + r'(x,y)$

exp : $g(x,y) = \exp(s(x,y)) = i_0(x,y)r_0(x,y)$



Homomorphic Filtering