A Model of the Image Degradation /Restoration Process

Image Restoration: Noise Removal

- What is image restoration?
- Noise and images
- Noise models
- Noise removal using spatial domain filtering
- Periodic noise
- Noise removal using frequency domain filtering

Image Restoration

- Goal of restoration technique is to improve an image in some predefined sense.
- Restoration attempts to reconstruct or recover an image that has been degraded by using a prior knowledge of the degradation phenomenon.
- Restoration techniques are oriented towards modeling the degradation and applying the inverse process in order to recover the original image.

Image Restoration and Image Enhancement

- Image restoration differs from image enhancement in that the latter is concerned more with accentuation or extraction of image features rather than restoration of degradations.
- Image restoration problems can be quantified precisely, whereas enhancement criteria are difficult to represent mathematically.
- Enhancement techniques –

  Example: Contrast Stretching
- Image Degradation –

  Example: Image Blur

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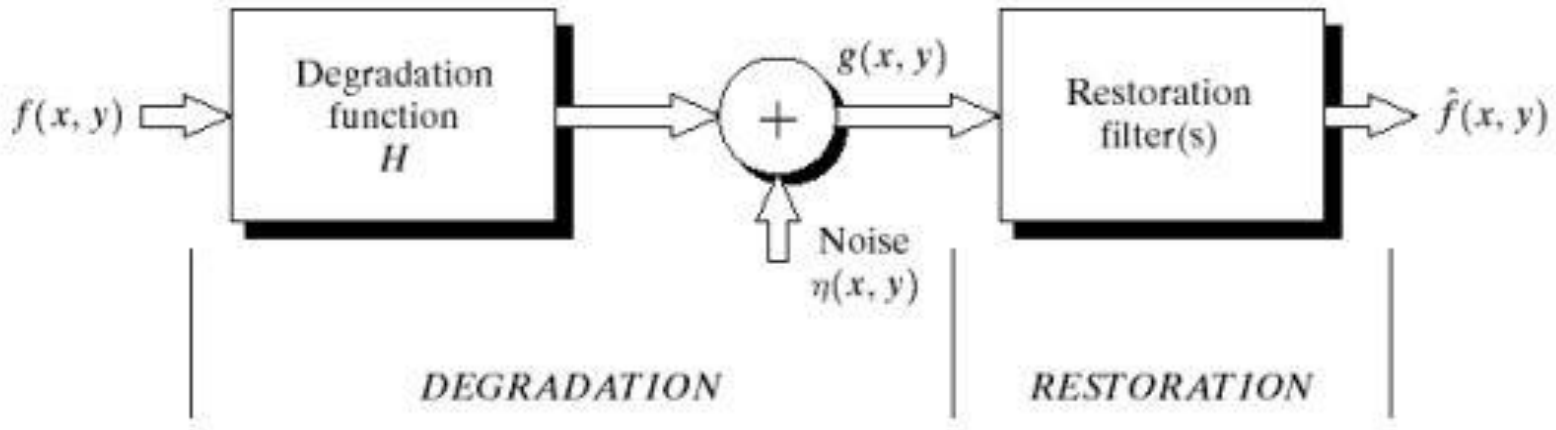

What is Image Restoration?

Image restoration attempts to restore images that have been degraded

- Identify the degradation process and attempt to reverse it
- Similar to image enhancement, but more objective

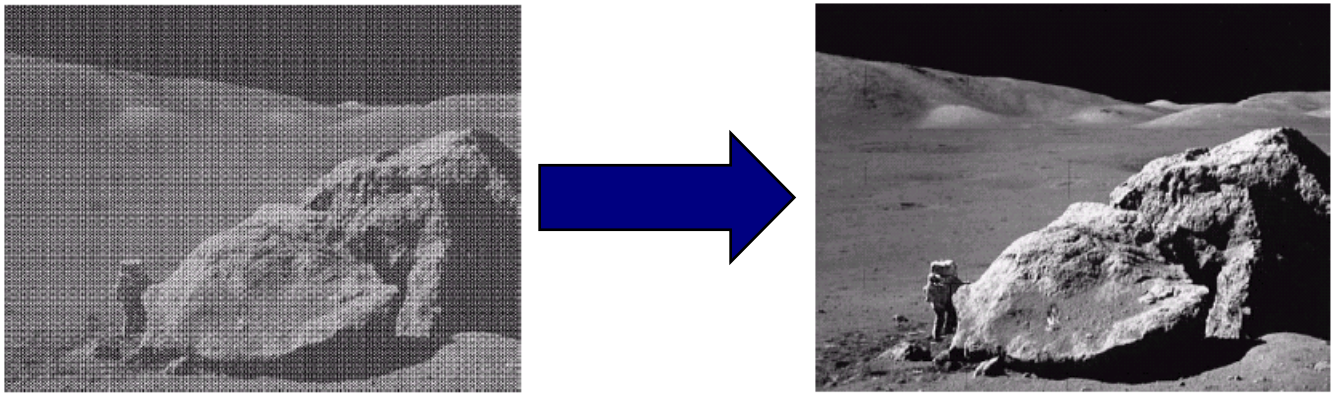

Image Degradation

- The degradation process for an image uses a degradation function together with an additive noise term.
- This operates on an input image f(x, y) to produce a degraded image g(x, y)
- Given g(x, y), some knowledge of the degradation function H, some knowledge about the additive noise term η(x, y) the objective of restoration is to obtain an estimate f^(x, y) will be to f(x, y).

Spatial and Frequency Domain Representation

- If H is a linear, position-invariant process, then the degraded image is given in the spatial domain by

  $g(x, y)=h(x, y) * f(x, y)+ \eta(x, y)$

  Where,

  h(x, y)–spatial representation of the degradation function

  * - indicates spatial convolution

  η(x, y)- Additive noise term

  f(x, y)- Input Image

- The degraded image is given in the frequency domain by

  $G(u, v)= H(u, v)F(u, v)+N(u, v)$

  Where,

  The terms in capital letters are the Fourier transforms of the terms in the above equation.

Noise in Image Degradation

- All natural images when displayed have gone through some sort of degradation:
  - During display mode
  - Acquisition mode, or
  - Processing mode
- The degradations may be due to
  - Sensor noise
  - Blur due to camera misfocus
  - Relative object-camera motion
  - Random atmospheric turbulence
- *In most of the existing image restoration methods we assume that the degradation process can be described using a mathematical model.*

Noise and Images

The sources of noise in digital images arise during image acquisition (digitization) and transmission

- Imaging sensors can be affected by environmental conditions, Quality of sensing {Eg: CCD camera, light levels, sensore temperature are major factors}

- Interference can be added to an image during transmission {Eg: Due to interference in channel ie, image transmitted using wireless network corrupted by lightning, atmospheric disturbance}

Examples