Image Restoration

CSE 4883: Digital Image Processing

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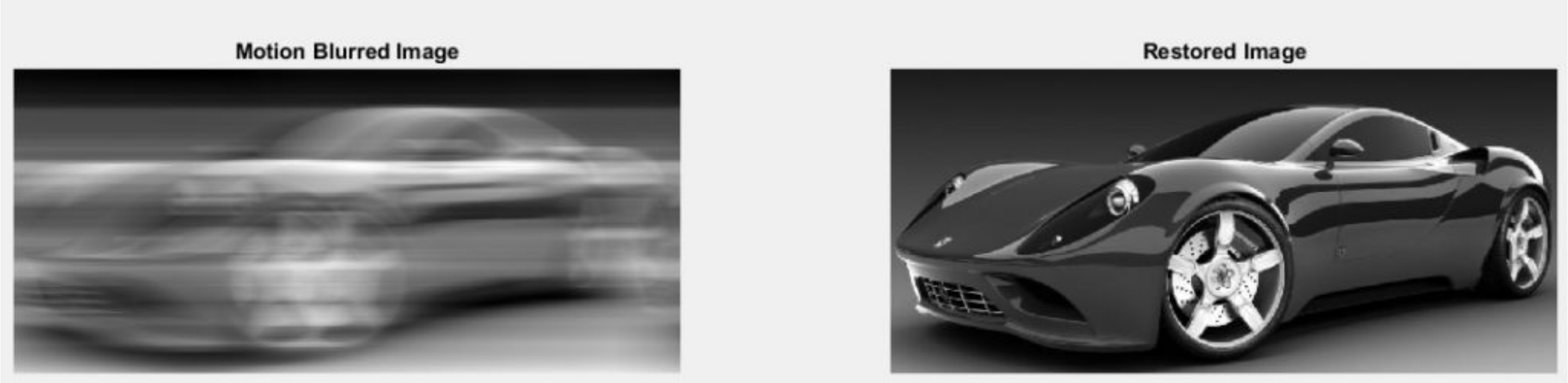
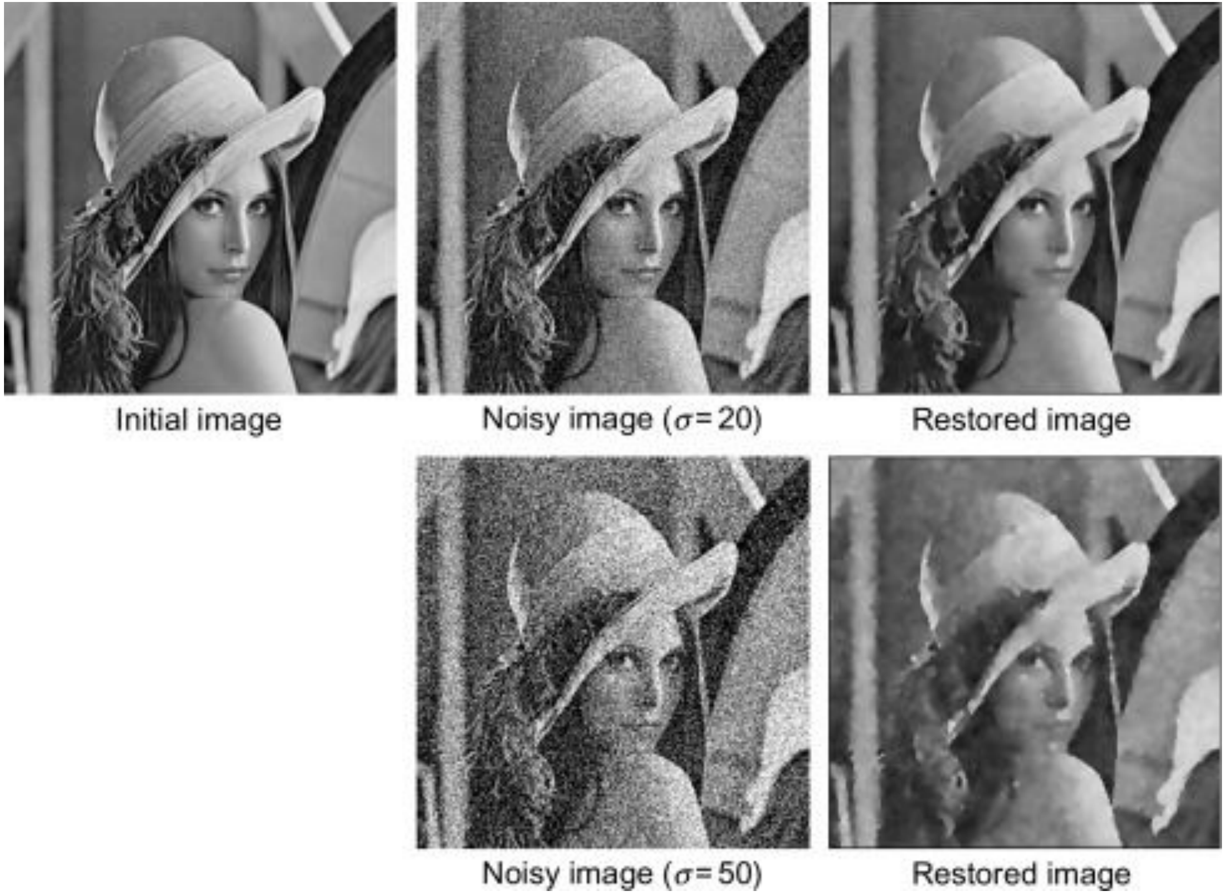
Introduction



Introduction



Introduction

Types of Image Degradation:

1. **Noise**: Noise can be introduced during image acquisition or transmission, resulting in random variations in pixel values. Common types of noise include Gaussian noise, salt-and-pepper noise, and speckle noise.

2. **Blur**: Blur occurs when the image is not sharply focused, resulting in a loss of detail and sharpness. Blur can be caused by factors such as motion blur, defocus blur, or optical aberrations.

Introduction

Image Restoration Techniques:

- **Filtering:** Filtering techniques are commonly used for image restoration. Different filters can be applied depending on the type of degradation present in the image. For example:
- **Noise Reduction:** Techniques such as median filtering, Gaussian filtering, or bilateral filtering can be used to reduce noise while preserving image details.
- **Deblurring:** Deblurring techniques aim to recover the sharpness and detail lost due to blur. This can be achieved using methods like Wiener filtering, blind deconvolution, or inverse filtering.

Model-based Approaches:

Model-based approaches assume a mathematical model of the degradation process and aim to estimate the parameters of this model to recover the original image. For example:

- **Restoration Using PSF Estimation:** In cases of blur, estimating the point spread function (PSF) of the blur is crucial. Once the PSF is estimated, techniques like Richardson-Lucy deconvolution or maximum likelihood estimation can be used to restore the image.
- **Sparse Representation-based Restoration:** This approach assumes that the image can be represented as a sparse linear combination of basis functions. By promoting sparsity, the original image can be recovered from noisy or blurred observations.

Deep Learning-based Approaches

Deep learning techniques, particularly convolutional neural networks (CNNs), have shown promising results in image restoration tasks. These methods learn complex mappings directly from input degraded images to their corresponding clean versions.

- **Image Denoising:** CNN-based denoising models are trained to map noisy images to their noise-free counterparts.
- **Image Deblurring:** CNNs can also be trained to learn the mapping between blurry images and their sharp counterparts.

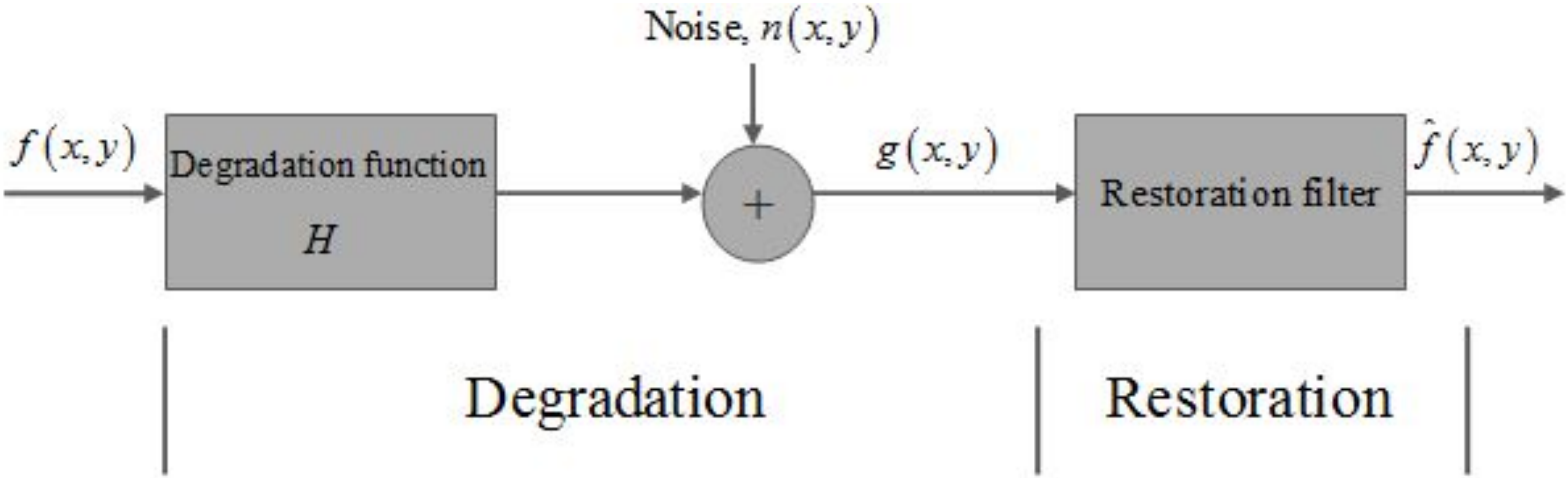
Evaluation and Quality Metrics

When evaluating image restoration algorithms, it's important to consider both objective and subjective quality metrics. Objective metrics include measures like

- peak signal-to-noise ratio (PSNR) and
- structural similarity index (SSIM),

while subjective evaluation involves human observers rating the visual quality of the restored images.

Fundamental Equation



Fundamental Equation

In spatial domain, the degradation of the original image can be modeled as:

$$g(x, y) = h(x, y) * f(x, y) + n(x, y) \;\ldots\ldots\; (1)$$

Where,

(x, y)= detached pixel coordinates of the image frame.

$f\,(x, y)$= Original image

$g\,(x, y)$= Degraded image

$h\,(x, y)$= Image degradation function

$n\,(x, y)$= Ad-on noise

More Info

[Further Concept]

[Fundamental Code]

Thank You