SUMMARY (CHAPTER 6)

1. Degradation and Noise
   - Images can be degraded in many ways and in various steps during image acquisition and operations.
   - Noise is one of the most popular sources of degradation, which is, in general, considered to be the disturbing/annoying signals of the required signals.
   - Signal-to-noise ratio (SNR) is a useful indication of the image quality with the presence of noise.
   - To describe the statistical behavior of the noise component of an image, the probability density function (PDF) is used. Typical examples include Gaussian noise, uniform noise, and impulse (salt-and-pepper) noise.

2. Degradation Model and Restoration Computation
   - In a simple model of image degradation, an operator $H$, which acts on the input image $f(x, y)$ and an additive noise $n(x, y)$ jointly produce the degraded image $g(x, y)$.
   - The properties of a degradation system may include linearity, additivity, homogeneity, and the position invariance.
   - The computation of a degradation model can be carried out with the convolution of the circulant matrix (for a 1-D case) or the block-circulant matrix (for a 2-D case).
   - Both a circulant matrix and a block-circulant matrix can be diagonalized.
   - The effect of the diagonalization is that the degradation model can be solved with the help of a few discrete Fourier transforms.

3. Techniques for Unconstrained Restoration
   - In unconstrained restoration, no a priori knowledge about the noise is assumed. The restoration is carried out in a least squares sense of the estimation error.
   - Inverse filtering is a commonly used restoration approach, which can be implemented in the Fourier domain.
   - Removal of the blur caused by uniform linear motion is a typical application of the techniques for the unconstrained restoration in a closed form.

4. Techniques for Constrained Restoration
   - In constrained restoration, some a priori knowledge of the noise is used to constrain the least square computation. The restoration is carried out using the method of Lagrange multipliers.
Wiener filtering is a statistical method for constrained restoration. It is based on the correlation matrices of the image and the noise. When there is no noise, the Wiener filter degrades to the ideal inverse filter. The constrained least square restoration only requires knowledge of the noise’s mean and variance, but the restoration is optimal for each image.

5. Interactive Restoration

Interactive restoration uses the advantage of human intuition to control the restoration process. Interactive restoration is suitable for eliminating the occurrence of a 2-D sinusoidal interference pattern (coherent noise).