Restoration Filters are the type of filters that are used for operation of noisy image and estimating the clean and original image. It may consists of processes that are used for blurring or the reverse processes that are used for inverse of blur. Filter used in restoration is different from the filter used in enhancement process. Types of Restoration Filters: There are three types of Restoration Filters: Inverse Filter, Pseudo Inverse Filter, and Wiener Filter. These are explained as following below. 1. Inverse Filter: Inverse Filtering is the process of receiving the input of a system from its output. It is the simplest approach to restore the original image once the degradation function is known. It can be define as: H'(u, v) = 1 / H(u, v) Let, F'(u, v) -> Fourier transform of the restored image G(u, v) -> Fourier transform of the degraded image H(u, v) -> Estimated or derived or known degradation function then F'(u, v) = G(u, v)/H(u, v) where, G(u, v) = F(u, v).H(u, v) + N(u, v) and F'(u, v) = f(u, v) - N(u, v)/H(u, v) Note: Inverse filtering is not regularly used in its original form. 2. Pseudo Inverse Filter: Pseudo inverse filter is the modified version of the inverse filter and stabilized inverse filter. Pseudo inverse filtering gives more better result than inverse filtering but both inverse and pseudo inverse are sensitive to noise. Pseudo inverse filtering is defined as: H'(u, v) = 1/H(u, v), H(u, v)!=0 H'(u, v) = 0, otherwise 3. Wiener Filter: (Minimum Mean Square Error Filter). Wiener filter executes and optimal trade off between filtering and noise smoothing. IT removes the addition noise and inputs in the blurring simultaneously. Weiner filter is real and even. It minimizes the overall mean square error by: e^2 = F{(f-f')^2} where, f -> original image f' -> restored image E{.} -> mean value of arguments H(u, v) = H'(u, v)/(|H(u, v)|^2 + (Sn(u, v)/Sf(u, v)) where H(u, v) -> Transform of degradation function Sn(u, v) -> Power spectrum of the noise Sf(u, v) -> Power spectrum of the undergraded original image No blur only additive noise: H(u, v)=1 W(u, v) = 1 / (1 + Sn(u, v)/Sf(u, v)) W(u, v) = SNR/(1 + SNR) where, SNR = Sf(u, v)/Sn(u, v) No noise only blur: Sn(u, v)=0 W(u, v) = 1/H(u, v) Drawbacks of Restoration Filters: Not effective when images are restored for the human eye.Cannot handle the common cause of non-stationary signals and noise.Cannot handle spatially variant blurring point spread function. Skip to main content Powered by AI and the LinkedIn community Noise is an inevitable and often unwanted component of many signals, especially in digital signal processing (DSP). It can degrade the quality, accuracy, and intelligibility of the signal, and make it harder to extract the desired information. One way to reduce noise in DSP is to use a wiener filter, a linear filter that minimizes the mean square error between the input and the output. In this article, we will explore what a wiener filter is, how it works, and what are its advantages and disadvantages for noise reduction in DSP. Like Celebrate Support Love Insightful Funny 4 Next: Regularization Up: EE381K Multidimensional Digital Signal Previous: Inverse Filter Solution Figure 3: The Wiener filtering solution for image restoration. The Wiener filter is the one that minimizes If the measurement noise is white, this gives The Wiener filtering approach is shown in Fig. 3. Advantages Begins to exploit signal Controls output error Straightforward to design Disadvantages Results often too blurred Spatially invariant Brian L. Evans Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. The most important technique for removal of blur in images due to linear motion or unfocussed optics is the Wiener filter. From a signal processing standpoint, blurring due to linear motion in a photograph is the result of poor sampling. Each pixel in a digital representation of the photograph should represent the intensity of a single stationary point in front of the camera. Unfortunately, if the shutter speed is too slow and the camera is in motion, a given pixel will be an amalgram of intensities from points along the line of the camera's motion. This is a two-dimensional analogy to where F is the fourier transform of an "ideal" version of a given image, and H is the blurring function. In this case H is a sinc function: if three pixels in a line contain info from the same point on an image, the digital image will seem to have been convolved with a three-point boxcar in the time domain. Ideally one could reverse-engineer a Fest, or F estimate, if G and H are known. This technique is inverse fitering. 2-D Fourier Transform of Horizontal Blur It should be noted that the image restoration tools described here work in a similar manner for cases with blur due to incorrect focus. In this case the only difference is in the selection of H. The 2-d Fourier transform of H for motion is a series of sinc functions in parallel on a line perpendicular to the direction of motion; and the 2-d Fourier transform of H for focus blurring is the sombrero function, described elsewhere. In the real world, however, there are two problems with this method. First, H is not known precisely. Engineers can guess at the blurring function for a given circumstance, but determination of a good blurring function requires lots of trial and error. Second, inverse filtering fails in some circumstances because the sinc function goes to 0 at some values of x and y. Real pictures contain noise which becomes amplified to the point of destroying all attempts at reconstruction of an Fest. The best method to solve the second problem is to use Wiener filtering. This tool solves an estimate for F according to the following equation: K is a constant chosen to optimize the estimate. This equation is derived from a least squares method. An example of Wiener filtering is given below. An ideal version of the cover of the Joshua Tree album by U2. All examples used are 256x256 pixels, but the same principles apply if size is varied. Also, the examples are all grayscale but the principles are valid for color photos by applying filtering techniques seperately to rgb elements. The same photograph, with some blurring due to motion and noise due to poor development.> Random gaussian noise (multiplied here by a factor of 100) added into the blurred version of the photo. Reconstructed photograph, e.g. f estimate, through Wiener filtering In closing, it should be noted that Weiner filters are far and away the most common deblurring technique used because it mathematically returns the best results. Inverse filters are interesting as a textbook starting point because of their simplicity, but in practice Wiener filters are much more common. It should also be re-emphasized that Wiener filtering is in fact the underlying premise for restoration of other kinds of blur; and being a least-mean-squares technique, it has roots in a spectrum of other engineering applications. Topics Inverse and Psuedoinverse Filtering Defocused Images Return to Main Page References