"Image Restoration and Reconstruction"

All image formation systems are inherently resolution limited. Moreover, some images can be blurred and/or distorted due to a variety of physical effects that determine the nature of the Point Spread Function, such as motion in the object or image planes, the effects of turbulence, light diffusion, limited aperture size and other physical effects. When an image is recorded that has been degraded in this manner, a number of digital image processing techniques can employed to 'de-blur' the image and enhance its information content. Nearly all of these techniques are either directly or indirectly based on a mathematical model for the blurred image which involves the convolution of two functions, i.e. the Point Spread Function and the object function. Hence, 'de-blurring' an image amounts to solving the inverse problem posed by this model which is known as *Deconvolution*. Deconvolution depends critically on *a priori* knowledge of the way in which the data (the digital image) have been generated and recorded. Mathematically, the data obtained are usually related to some object function via an integral transform. In this sense deconvolution is concerned with inverting certain classes of integral equation, in particular, the convolution integral. In general, there is no exact or unique solution to this problem because it is usually ill-posed. We attempt to find a 'best estimate' based on some physically viable criterion subject to certain conditions. Image restoration attempts to provide a resolution compatible with the bandwidth of the imaging system (a resolution limited system). Image reconstruction attempts to provide a resolution that is greater than the inherent resolution of the data (i.e. the resolution limit of the imaging system). This is often known as super resolution. In addition to this general inverse problem, there are specific deconvolution problems such as the reconstruction an image from a set of projections and specialist problems such as the phase reconstruction problem. The aim of this lecture is to discuss: (i) basic methods of solution; (ii) essential algorithms; (iii) some applications

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