## 5.1 Photorefractive Memories for Optical Processing Applications

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Three dimensional holographic memories have experienced a renewed interest in the last couple of years. We have studied the principles underlying holographic data storage and the related theoretical and practical limits on the storage capacity identifying the limitations due to the optical system, hologram cross-talk and material imperfections. Angular, wavelength and phase multiplexing techniques as well as sequential and incremental recording schemes for writing multiple holograms in photorefractive materials have been compared in terms of dynamic range, cross-talk, signal-to-noise ratio and hologram strength homogeneity. Principles and practical realizations of optical processing systems based on photorefractive memories have been analyzed with a particular emphasis on Joint-Fourier transform and VanderLugt type correlators, as well as holographic associative memories. Our implementation of an all optical associative memory system containing three photorefractive crystals and an adjustable saturable absorber is able to correctly reconstruct ten different stored images using only partial inputs. Only a very small amount (≈1/500) of one of the stored objects has to be presented at the input plane in order to associate the correct object and get full reconstruction of the stored data. The problem of distinguishing between enclosed stored objects, that has not been discussed previously in the context of nonlinear holographic memories, has been solved by a novel weighted storage scheme. Using this scheme, discrimination of highly correlated patterns and correlation of enclosed objects using only a partial input have been successfully verified.