5.1 All Optical Associative Memory Using Photorefractive Crystals

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Associative memories are storage devices in which an input set of data recalls another set of associated data. In particular, they have the property that an incomplete or distorted image can be used to retrieve the complete and correct version of an image that is most similar to the input.

One serious problem encountered by associative memories is to distinguish between enclosed images, e.g. I and H, or between images which have a large difference in their overall transmittance. We have developed a storage scheme for amplitude modulated images that eliminates this problem in nonlinear holographic associative memories. Our method is based on controlling the diffraction efficiency of each hologram corresponding to a stored image. We worked out that the diffraction efficiency of each hologram depends mainly on the overall transmission of the stored objects. With this method five strongly correlated black-and-white images have been stored in our all-optical associative memory set-up that utilises three photorefractive crystals and a saturable absorber. We were able to recognise and read-out each of these stored images using only a partial input, although these images had a large overlap with each other or were even enclosed by other images. To further test the theory the whole alphabet was stored. Using a hybrid sytem each letter has been successfully readout using only partial inputs. Without storing the images with different diffraction efficiencies, it is not possible to distinguish between each letter, e.g. I from H and K or the letter C from O.

We may conclude that a weighted storage method allows the discrimination of highly correlated patterns in nonlinear holographic associative memories. It is even possible to associate enclosed images using a partial input. The weighted storage helps the associative memory to recognise the most similar image among the stored ones and to read it out.