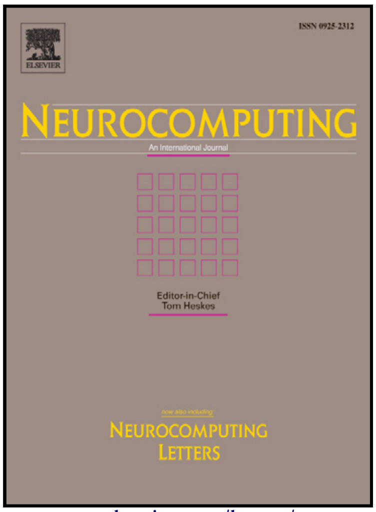

www.elsevier.com/locate/neucom

Efficient recording and retrieval of complex digital Fresnel Holograms based on the line partitioned autoassociative memory

P.W.M. Tsang, K.T. Ng

PII: S0925-2312(15)00379-3
DOI: http://dx.doi.org/10.1016/j.neucom.2014.07.080
Reference: NEUCOM15305

To appear in: *Neurocomputing*

Received date: 4 April 2014
Revised date: 4 June 2014
Accepted date: 5 July 2014

Cite this article as: P.W.M. Tsang, K.T. Ng, Efficient recording and retrieval of complex digital Fresnel Holograms based on the line partitioned autoassociative memory, *Neurocomputing*, http://dx.doi.org/10.1016/j.neucom.2014.07.080

Efficient Recording and Retrieval of Complex Digital Fresnel Holograms based on the Line Partitioned Autoassociative Memory

P.W.M. Tsang,[1] *K.T. Ng*[1]
[1] *Department of Electronic Engineering, City University of Hong Kong*

eewmtsan@cityu.edu.hk

Abstract
In this paper, a novel method for the recording and retrieval of multiple digital Fresnel holograms, each corresponding a three dimensional (3D) object scene, is presented. As the hologram is complex (composing of a real and an imaginary parts), and its data size is generally larger than the optical image it represents, a classical AAM required to record the holographic data is enormous even for a medium size hologram. In view of this, we first convert the hologram into a binary format with error diffusion (a process hereafter refer to as 'binarization'). Each row of the hologram is record in a sub-autoassociative memory (SAAM), resulting in a network that is over 4 orders of magnitude smaller in size than the use of a single, classical AAM for recording the hologram directly. Our proposed AAM is referred to as the line partitioned autoassociative memory (LP-AAM). Experimental results demonstrate that our proposed LP-AAM is effective in retrieving a binary hologram when a corrupted or noise contaminated version of it is presented. Subsequently, the retrieved binary hologram can be taken to reconstruct the pictorial content with a quality that is comparable to that represented by the original hologram before binarization. To our knowledge, this is the first time an autoassociative memory is developed for the handling of holographic images.

Keywords: Fresnel holograms, Autoassociative memory, Sub-autoassociative memory, Line partitioned autoassociative memory, Hebbian learning, error diffusion.

1. Introduction
Autoassociative memory (AAM) [1] is an interesting type of artificial neural network that mimics the storage mechanism of the human brain. Multiple groups of data to be recorded are each organized into a vector and stored in the AAM via certain training algorithm. Subsequently, the stored data can be retrieved when a partial, or a noise contaminated version of it is presented. A popular means of realizing the AAM is a Hopfield network [2], which is comprising of a set of fully connected neurons with the connection weights between them represented by a two dimensional weight matrix. When an input pattern is presented, the AAM will output a corresponding pattern constituted by the weighted sum of the input elements. In order to establish an association between the input and the output data, the weight matrix have to be correctly determined. In general this process can be effectively achieved with the use of the Hebbian learning.

The auto-association capability of an AAM has found important applications in the processing and handling of images, for example in optical image recording [3]-[5], and pattern recognition [6][7]. All these works imply, either directly or indirectly, that