



A lifting based system for compression and classification trade off in the JPEG2000 framework

G.F. Fahmy* and S. Panchanathan

*Visual Computing and Communications Laboratory, Research Center for Ubiquitous Computing (CubiC),
Department of Computer Science and Engineering Arizona State University, USA*

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Abstract

In this paper, we propose a design for a novel lifting based wavelet system that achieves the best trade off between compression and classification performances. The proposed system is based on bi-orthogonal filters and can operate in a scalable compression framework. In the proposed system, the trade off point between compression and classification is determined by the system, however, the user can also fine-tune the relative performance using two controllers (one for compression and one for classification). Extensive simulations have been performed to demonstrate the compression and/or classification performance of our system in the context of the recent image compression standard, namely JPEG2000. Our simulation results show that the lifting based kernels, generated from the proposed system, are capable of achieving superior compression performance compared to the default kernels adopted in the JPEG2000 standard (at a classification rate of 70%). The generated kernels can also achieve a comparable compression quality with the JPEG2000 kernels whilst providing a 99% classification performance. In other words, the proposed lifting based system achieves the best trade off between compression and classification performance at the compressed bit-stream level in the wavelet domain.

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1. Introduction

The rapid growth of visual media in many applications has led to the proliferation of a variety of compression standards including the recent MPEG-4 (ISO/IEC JTC1/

* Corresponding author.

E-mail addresses: fahmy@asu.edu (G.F. Fahmy), panch@asu.edu (S. Panchanathan).

SC29/WG11, 1998) and JPEG2000 (Taubman, 2000) standards for image/video compression. It is therefore likely that visual media will be increasingly stored in the compressed format. Visual indexing techniques are also becoming important because of the requirements for retrieving visual information from multimedia databases. Potential applications include, multimedia information systems, digital libraries, interactive television, etc. The upcoming MPEG-7 (ISO, 2000) standard proposes content descriptors, which succinctly describe the visual content for the purposes of efficient retrieval. Since not all images/videos are indexed prior to compression, there is a requirement for sophisticated compressed domain indexing techniques, where the visual information is retrieved based on compressed domain features.

Classification is an important step in visual indexing. In this paper, we use the terms classification and indexing interchangeably. Combined compression and classification are therefore becoming an important research issue in the context of efficient storage and retrieval of visual media in a variety of applications. Exploring classification in compressed domain has the advantages of faster search and retrieval. It also reduces the memory required for storing on-line data.

Several combined compression and indexing techniques have been recently reported in the literature, which employ the compressed domain features as indices. In (Mandal et al., 1997), a wavelet based compression and indexing system has been presented. It employs Legendre moments of the wavelet coefficients as an index. In (Mandal, 1998), an indexing technique based on the histograms in the wavelet domain has been detailed. Only features derived from the high frequency bands are used to distinguish between various textures. Acceptable retrieval results has been obtained using this approach, however, it is computationally expensive because of the up-sampling process required for the high frequency bands. In (Liang and Jay Kuo, 1999), a wavelet-based image representation and description approach has been presented, where the images are indexed and compressed simultaneously. This greatly simplifies the image database management problem, however, the feature descriptors generated during the encoding process are only based on the sub-band energies, which do not effectively describe the image content. In (Chang and Jay Kuo, 1993), a texture analysis scheme has been presented based on an irregular tree decomposition structure, where the middle resolution sub-band coefficients are used for texture matching. In this scheme, J dimensional feature vector is generated consisting of the energy of the J most important sub-bands. Indexing is performed by matching the feature vector of the query image with those of the target images in the database. In (Bhalod et al., 2000), a still texture object indexing scheme is proposed for use in the MPEG-4 framework, retrieval is based on the auto correlation values of the objects in all the wavelet channels. In (Bhalod, 2000), a texture classification approach has been presented that uses the Mallat exponential algorithm (Mallat, 1989) to model textures at all wavelet levels. A technique for texture classification using cooccurrence features has been first proposed in (Haralick et al., 1973), which has been later used in the wavelet domain in (Van de Wouwer et al., 1999). Second order statistics have been extracted using these cooccurrence signatures. Good retrieval results were obtained using this approach in addition to its low

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