

Chapter XLV

Visual Pattern Based Compressed Domain Image Retrieval

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ABSTRACT

While image retrieval and image compression have been pursued separately in the past, compressed domain techniques, which allow processing or retrieval of images without prior decompression, are becoming increasingly important. In this chapter we show that such midstream content access is possible and present a compressed domain retrieval method based on a visual pattern based compression algorithm. Experiments conducted on a medium sized image database demonstrate the effectiveness and efficiency of the presented approach.

INTRODUCTION

With the rise of the Internet and the availability of affordable digital imaging devices, the need for content-based image retrieval (CBIR) is ever increasing. While many methods have been suggested in the literature only few take into account the fact that—due to limited resources such as disk space and bandwidth—virtually all images are stored in compressed form. In order to process them for CBIR they first need to be uncompressed and the features calculated in the pixel domain.

Often these features are stored alongside the images which seems counterintuitive to the original need for compression. The desire for techniques that operate directly in the compressed domain providing, so-called midstream content access, is therefore evident (Picard, 1994). Colour Visual Pattern Image Coding (CVPIC) is one of the first so-called 4th criterion image compression algorithms (Schaefer & Qiu, 2000; Schaefer, Qiu, & Luo, 1999). A 4th criterion algorithm allows—in addition to the classic three image coding criteria of image quality, efficiency, and bitrate—the im-

age data to be queried and processed directly in its compressed form; in other words the image data is directly meaningful without the requirement of a decoding step. The data that is readily available in CVPIC compressed images is the colour information of each of the 4×4 blocks the image has been divided into, and information on the spatial characteristics of each block, in particular on whether a given block is identified as a uniform block (a block with no or little variation) or a pattern block (a block where an edge or gradient has been detected).

In this chapter we show how to make direct use of this information and present an image retrieval algorithm that allows for efficient and effective retrieval directly in the compressed domain of CVPIC. We utilise the fact that colour and edge information is readily available in CVPIC and extract these features with suitable methods. Integrating the two scores achieves image retrieval based on both (spatial) colour and shape aspects. Experimental results obtained from querying the UCID dataset (Schaefer & Stich, 2004) show that this approach not only allows retrieval directly in the compressed domain but also outperforms techniques such as colour histograms, colour coherence vectors and color correlograms.

COLOUR VISUAL PATTERN IMAGE CODING (CVPIC)

The Colour Visual Pattern Image Coding (CVPIC) image compression algorithm introduced in (Schaefer et al., 1999) is an extension of the work in (Chen & Bovic, 1990). The underlying idea is

that within a 4×4 image block only one discontinuity is visually perceptible.

CVPIC first performs a conversion to the CIEL*a*b* colour space (CIE, 1986) as a more appropriate image representation. As many other colour spaces, CIEL*a*b* comprises one luminance and two chrominance channels. CIEL*a*b* however, was designed to be a uniform representation, meaning that equal differences in the colour space correspond to equal perceptual differences. A quantitative measurement of these colour differences was defined using the Euclidean distance in the L*a*b* space and is given in ΔE units.

A set of 14 patterns of 4×4 pixels has been defined in (Chen & Bovic, 1990). All these patterns contain one edge at various orientations (vertical, horizontal, plus and minus 45°) as can be seen in Figure 1 where + and - represent different intensities. In addition a uniform pattern where all intensities are equal is being used.

The image is divided into 4×4 pixel blocks. Determining which visual pattern represents each block most accurately then follows. For each of the visual patterns the average L*a*b* values for the regions marked by + and - respectively (i.e., the mean values for the regions on each side of the pattern) are calculated.

The colour difference of each actual pixel and the corresponding mean value is then obtained and averaged over the block. The visual pattern that leads to the lowest difference value (given in CIEL*a*b* ΔE units) is chosen.

In order to allow for the encoding of uniform blocks the average colour difference to the mean colour of the block is also determined. A block is coded as uniform if either its variance in colour is

Figure 1. The 14 edge patterns used in CVPIC

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