Image Identification using Compression Technique

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ABSTRACT
Image identification from still or video images is emerging as an active research area with numerous commercial and law enforcement applications. Image is represented as single or multiple arrays of pixel values. Features that uniquely characterize the object are determined. The arrays are compared with a stored pattern feature set obtained during training procedure. Number of matches of the object in the image must be obtained. As the image consists of a large amount of data, it has to be compressed using a compression technique so that data reduction is achieved. This reduced data is used for comparison process. This image identification technique can be used to recognize objects in specific areas. These identification techniques find its applications in robotics. The robot's primary sensor is the video camera. A proprietary vision algorithm lets the robot see, recognize, and avoid running into objects. The robot can also recognize where it is, analyze images, and select features such as colours and edges for comparison to a database of instances it knows about. For example, it knows it has collided with a wall when the image stops moving. The robot can be trained to recognize thousands of objects from examples it sees. The vision algorithm lets the robot recognize objects even if their orientation or lighting differs from the example. Recognition capabilities increase with a higher resolution camera.

Keywords: **Image compression, Image Identification, Wavelet, JPEG, Robot.**

1. INTRODUCTION
Advances in wavelet transforms and quantization methods have produced algorithms capable of suppressing the existing image compression standards like the Joint Photographic Experts Group (JPEG) algorithm. For best performance in image compression, wavelet transform require filters that combine a number of desirable properties, such as orthogonality and symmetry. Logarithms based on wavelets have been shown to work well in image compression. The wavelet transform is a type of transform that are commonly used in image compression.

With the continual expansion of multimedia and Internet applications, the needs and requirements of the technologies used, grew and evolved. To address these needs and requirements in the specific area of still image compression, many efficient techniques with considerably different features have recently been developed for both lossy and lossless compression. The evaluation of lossless techniques is a simple task where compression ratio and execution time are employed as standard criteria. Contrary, the evaluation of lossy techniques is difficult task because of inherent drawbacks associated with the objective measures of image quality, which do not correlate well with subjective quality measures.

Since the mid-80s, members from both the International Telecommunication Union (ITU) and the International Organization for Standardization (ISO) have been working together to establish an international standard for the compression of grayscale and colour still images. This effort has been known as JPEG, the Joint Photographic Experts Group. Officially, JPEG corresponds to the ISO/IEC international standard 10928-1, digital compression and coding of continuous-tone (multilevel) still images. After evaluating a number of coding schemes, the JPEG members selected a Discrete Cosine Transform (DCT) based method. JPEG became a Draft International Standard (DIS) in 1991 and an International Standard (IS) in 1992.

Much research has been undertaken on still image coding since JPEG standard was established. JPEG2000 is an attempt to focus these research efforts into a new standard for coding still images. The standardization process has already produced the Final Draft International Standard (FDIS). One of the aims of the standardization committee has been the development of Part I, which could be used on a royalty and fee free basis. This is important for the standard to become widely accepted, in the same manner as the original JPEG is now. The scope of JPEG2000 includes not only new compression algorithms, but also flexible compression architectures and formats. The standard intends to compliment and not to replace the current JPEG standards. It addresses areas where current standards fail to produce the best quality or performance. JPEG2000 should provide low bitrate operation (below 0.25 bits/pixel) with subjective image quality performance superior to existing standards, without sacrificing performance at higher bitrates. Image compression scheme in JPEG2000 Part I is based on discrete wavelet transform (DWT).

2. WAVELET THEORY
Both wavelet theory and wavelet-based image compression are complex and evolving subjects. This section gives a brief high-level overview of these topics

2.1 Wavelets
Wavelets are a mathematical tool for representing and approximating functions hierarchically. At the heart of wavelet theory, there is a single function ψ, called the mother wavelet. Any function can be represented by superimposing translated and dilated versions of ψ, denoted by ψ j, i, where i and j are the translation and dilation parameter. We are focusing on the discrete

case where i and j only take on integer values. The ψ j, i can be computed from the mother wavelet as

$$\psi_{j,i}(x) = 2^{\frac{j}{2}}(2^{j}x - i) \tag{1}$$

The process of decomposing a function into wavelet coefficients (a scaling factor for each of the $\psi_{j,i}$) is called wavelet transform. If the parameters i and j take on discrete values, we have a discrete wavelet transform or DWT, essentially leading to a finite number of coefficients.

In order to compute the DWT of a function f, we need to find one wavelet coefficient $\gamma_{j,i}$ for each $\psi_{j,i}$, such that

$$f = \sum_{j,i} \gamma_{j,i}\psi_{j,i} \tag{2}$$

If a wavelet basis (i.e. the set of all $\psi_{j,i}$) is orthogonal then the $\gamma_{j,i}$ are given by

$$\gamma_{j,i} = \left\langle f, \psi_{j,i} \right\rangle = \int_{\infty}^{\infty} f(x)\overline{\psi_{j,i}}(x)dx \tag{3}$$

where the bar denotes the complex conjugate. Otherwise, a dual wavelet $\overline{\psi}$ is necessary such that ψ and $\overline{\psi}$ together are biorthogonal, which basically means that the transform must be invertible. We can then use $\overline{\psi}$ for determining the wavelet coefficients (equation 3), and the original wavelet for the inverse DWT (equation 2). Note that an orthogonal wavelet is just a special case of a biorthogonal one where $\overline{\psi} = \psi$.

2.2 Wavelet based Image Compression

All modern image coders are transform coders, i.e. they have the structure shown in figure 3. Transform coders first apply an invertible transform to the image data in order to decorrelate it. Examples of such transforms are the discrete cosine transform (the basis for JPEG compression), and the discrete wavelet transform, the basis for JPEG2000 and other wavelet coders.

The performance of a transform coder depends largely on how well the transform decorrelates the signal. A well decorrelated signal consists mainly of coefficients close to zero.

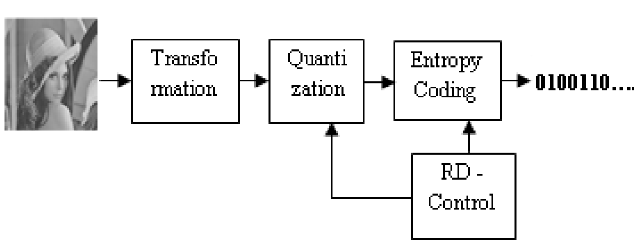

Figure1. The structure of a transform coder.

The signal is first decorrelated using an invertible transform, and then quantized and entropy coded. The rate-distortion (RD) unit controls the quantization to minimize the distortion within the available bit rate. The performance of a transform coder depends on how well the transform decorrelates the image data.

After the transform step, the coefficients are quantized, i.e. expressed using symbols from a finite alphabet, and entropy coded, using as little space or bandwidth as possible. The rate-distortion (RD) unit controls the quantization in order to achieve minimal distortion within the available bit rate.

All three steps of an image coder have an impact on the image quality achieved for a given compression ratio. In particular, a better transform results in better compression performance.

3. JPEG COMPRESSION TECHNIQUES

The JPEG (named after Joint Photographers Expert Group) format uses lossy compression to achieve high levels of compression on images with many colours. The compression works best with continuous tone images, that is, images where the change between adjacent pixels is small but not zero.

First generation JPEG uses DCT and Run length Huffman entropy coding. Second generation JPEG (JPEG2000) uses wavelet transform, bit plane coding and Arithmetic entropy coding.

Transform coding has become a standard model for image coding. DCT based image codes have been developed and their performance studied. Despite the phenomenal performance of the JPEG baseline algorithm that out performed the existing schemes, there were some short comings which became apparent later. Various algorithms have been proposed to improve the performance of the compression scheme. Recent works have mainly concentrated on the use of the discrete wavelet transform (or DWT) in image coding and compression applications. JPEG's goal has been to develop a method for continuous-tone image generation which meets the requirements such as: Improved compression efficiency, Lossy to lossless compression, Multiple resolution representation, Embedded bit-stream (progressive and SNR scalability), Tiling, Region-of-interest (ROI) coding, Error resilience, Random code stream access and Improved performance to multiple compression/ decompression cycles.

Because theoretical analysis of JPEG and JPEG2000 image compression techniques is widely available. Lossy baseline JPEG is the very well known and popular standard for compression of still images. In baseline JPEG mode, the source image is divided in 8×8 blocks and each block is transformed using DCT. The data compression is achieved via quantization followed by variable length coding (VLC). The quantization step size for each of the 64 DCT coefficients is specified in a quantization table, which remains the same for all blocks in the image. In JPEG, the degree of compression is determined by a quantization scale factor. Increasing the quantization scale factor leads to coarser quantization, this gives higher compression and lower decoded image quality. The DC coefficients of all blocks are coded separately, using a predictive scheme. The block-based segmentation of the source image is fundamental limitation of the DCT-based compression system. The degradation is known as "blocking effect" and depends on compression ratio and image content. JPEG is very efficient coding method but the performance of block-based DCT scheme degrades at high compression ratio.

In recent time, much of the research activities in image coding have been focused on the Discrete Wavelet Transform (DWT) which has become a standard tool in image compression applications because of their data reduction capability. DWT offers adaptive spatial-frequency resolution (better spatial resolution at high frequencies and better frequency resolution at low frequencies) that is well suited to the properties of HVS. It can provide better image quality than DCT, especially at higher compression ratio.

JPEG2000 Part I coding procedure is based on DWT, which is applied on image tiles. The tiles are rectangular non-overlapping blocks, which are compressed independently. Using DWT tiles are decomposed into different decomposition (resolution) levels. These decomposition levels contain a number of subbands, which consist of coefficients that describe the horizontal and vertical spatial frequency characteristics of the original tile component. In JPEG2000 Part I power of 2 decompositions are allowed (dyadic decomposition) and two types of wavelet filters are implemented: Daubechies 9-tap/7-tap filter and 5-tap/3-tap filter. Due to its better performance for visually lossless compression, the 9-tap/7-tap filter is used by default. After transformation, all transform coefficients are quantized. Scalar quantization is used in Part I of the standard. Arithmetic coding is employed in the last part of the encoding process.

4. PICTURE QUALITY MEASURE

The image quality can be evaluated objectively and subjectively. Objective methods are based on computable distortion measures. Standard objective measures of image quality are Mean Square Error (*MSE*) and Peak Signal-to-Noise Ratio (*PSNR*) for the common case of 8 bits per picture element of input image. *MSE* and *PSNR* are the most common methods for measuring the quality of compressed images, despite the fact that they are not adequate as perceptually meaningful measures of picture quality. In fact, in image compression systems, the truly definitive measure of image quality is perceptual quality. The distortion is specified by mean opinion score (*MOS)* or by picture quality scale (*PQS*). *MOS* is result of perception based subjective evaluation described in ITU-R BT Rec. 500. *PQS* methodology was proposed in as perception based objective evaluation. It has been developed in the last few years for evaluating the quality of compressed images. In addition to the commonly used *PSNR*, we chose to use a perception based objective evaluation that is quantified by *PQS*. It combines various perceived distortions into a single quantitative measure and perfectly responds to a mean opinion score. To do so, *PQS* methodology uses some of the properties of HVS relevant to global image impairments, such as random errors, and emphasizes the perceptual importance of structured and localized errors. *PQS* is constructed by regressions with *MOS*, which is 5-level grading scale developed for subjective evaluation.

5. REFERENCES

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