STUDY AND ANALYSIS OF WAVELET APPROACH TO DEVELOP AN EFFICIENT JPEG 2000 ALGORITHM

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Abstract

The development of new technologies and communication networks creates new needs and stimulates the introduction of new functionalities. The current standards in the field of still image coding are inadequate for producing the best quality of performance. JPEG2000 is intended to provide subjective image quality performance superior to other existing image compression standards and expected to become universal file format for digital images. This paper discusses the comparative study between still image compression standard (JPEG 2000) and moving image compression standard (MPEG) and also various reliable requirements of JPEG 2000 applications. This paper is a literature survey on wavelet for efficient JPEG 2000 Algorithm. This paper also discussed about various methodologies of the JPEG 2000 applications especially for mobile and remote sensing.

Keywords: JPEG 2000, JPEG, MPEG, Fast Wavelet Transform, Quantizer, Encoder

I. INTRODUCTION

The importance of visual communications has increased tremendously in the last few decades. The development of new technologies and communication networks creates new needs and stimulates the introduction of new functionalities. The current standards in the field of still image coding are inadequate for producing the best quality of performance. To address this concern, ISO committee came up with a new coding system, JPEG 2000.

JPEG 2000 is a new digital imaging system that builds on JPEG but differs from it. It utilizes a Wavelet transform and an arithmetic coding scheme to achieve scalability in its design and operation. It offers improved compression, better quality for a given file size under most circumstances. This is especially true at very high compression. In exchange for better performance it is significantly more complex; typically it requires more processor cycles and more memory resources for equivalent tasks. At high compression, JPEG 2000 exhibits different kinds of typical compression artifacts to those of JPEG and to other compression systems.

Complexity in JPEG 2000 is a difficult issue, with no well-defined measure. It means different things for different applications. It can be memory bandwidth, total working memory, number of CPU cycles, number of hardware gates, etc. Furthermore, these numbers are very dependent on the optimization, targeted applications and other factors of the different implementations. We can provide the runtimes of the algorithms on a MATLAB implementation for an appreciation of the involved complexity.

II. MAIN FEATURES OF JPEG 2000 VERSUS OTHER STANDARDS

A. JPEG and JPEG 2000

It is the very well known ISO/ITU-T standard created in the late 1980s. There are several modes defined in JPEG, however, here we refer to only two baseline and lossless. The baseline mode is the most popular one and supports lossy coding only. The lossless mode is not popular but provides for lossless coding, although it does not support lossy. In the baseline mode, the image is divided in 8x8 blocks and each of these is transformed with the DCT. The transformed blocks are quantized with a uniform scalar quantizer, zigzag scanned and entropy coded with Huffman coding. The quantization step size for each of the 64 DCT coefficients is specified in a quantization table, which remains the same for all blocks.

PSNR values from Ref.[20] in dB for various bit error rates (ber)and compression rates for the JPEG baseline and the JPEG 2000.are given in the Table 1. below.

B. MPEG-4 VTC

MPEG-4 Visual Texture Coding (VTC) [8] is the algorithm used in MPEG-4 to compress visual textures and still images, which are then used in photo realistic 3D models, animated meshes, etc., or as simple still images. It

is based on the discrete wavelet transform (DWT), scalar quantization, zero- tree coding and arithmetic coding. The DWT is dyadic. The High compression efficiency, Lossless color transformations, Lossy and lossless coding in one algorithm, Embedded lossy to lossless coding, Progressive by resolution and quality, Static and dynamic Region-of-Interest, Error resilience, Visual (fixed and progressive) coding, Multiple component images, Block and line based transforms, Compressed image manipulation methods.

TABLE 1. Compression rates for the JPEG baseline and the JPEG 2000

bpp	ber	0	1e-6	1e-5
0.25	JPEG2000	23.06	23.00	21.62
	JPEG	21.94	21.79	20.77
0.5	JPEG2000	26.71	26.42	23.96
	JPEG	25.40	25.12	22.95
1.0	JPEG2000	31.90	30.75	27.08
	JPEG	30.84	29.24	23.65

In order to address areas that the current standards fail to produce the best quality of performance as JPEG 2000 have,

Low bit-rate compression:

Current standards, such as IS10918-1 (JPEG), offer excellent rate-distortion performance in the mid and high bit-rates at low bit-rates. Lossless and lossy compression: There is currently no standard that can provide superior lossless compression and lossy compression in a single code stream.

Large images:

The JPEG image compression algorithm does not allow for images greater then 64K by 64K without tiling.

Single decompression architecture:

The current JPEG standard has 44 modes, many of which are application specific and not used by the majority of the JPEG decoders.

Transmission in noisy environments:

The current JPEG standard has provision for restart intervals, but image quality suffers dramatically when bit errors are encountered.

Computer generated imagery:

The current standard was optimized for natural imagery and does not perform well on computer generated imagery.

Compound documents:

JPEG is seldom used in the compression of compound documents because of its poor performance when applied to bi-level (text) imagery.

III. PROPOSED ARCHITECTURE TO DEVELOP AN ALGORITHM

The main blocks JPEG2000 consists of Fast wavelet transform block, quantization block, Entropy encoding block. The main disadvantage of JPEG2000 scheme is it needs more computations as it is using wavelet transform hence more compression and decompression times. This is the reason JPEG2000 is not widely used as JPEG standard, even JPEG 2000 giving better compression ratio and better image quality. This drawback is going to be overcome by using fast wavelet transform, so reduced number of computations, compression and decompression times. Adoption of JPEG 2000 in the marketplace is growing and expected to continue.

The block diagram of the JPEG2000 encoder is illustrated below. The discrete transform is first applied on the source image data. The transform coefficients are then quantized and entropy coded, before forming the output code stream (bit stream) transformation is used. It is performed prior to computation of the forward component transform.

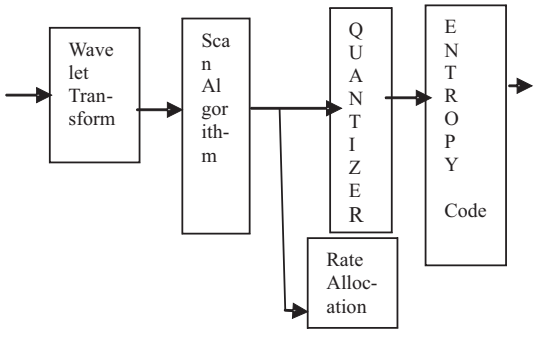

Fig. 1. JPEG 2000 Encoding Scheme

The source image is decomposed into components. The image and its components are decomposed into rectangular tiles. The tile-component is the basic unit of the original or reconstructed image. The encoding can be done in such a way, so that certain ROI's can be coded in a

a higher quality than the background. Markers are added in the bit stream to allow error resilience. [20] The code stream has a main header at the beginning that describes the original image and the various decomposition and coding styles that are used to.

IV. IMPORTANCE OF WAVELET APPROACH

There are several wavelet transforms.[16] for decomposing a signal into various sub bands such as Discrete Wavelet Transform (DWT), Wavelet Packets (WP), Adapted Wavelets etc,. Most of the wave let Coefficients in the details have very low values. Consequently most of these can be quantized to zero without affecting the perceived quality of the reconstructed image significantly. All wavelet based image compression techniques take advantage this phenomenon [18].

The Fast Wavelet Transform can solve the problem that the DWT matrix is not sparse by factoring the DWT into a few sparse matrices using self similarity properties. The proposed algorithm can require the equal number of operations to transform the same number of samples. The wavelet transform is implemented by using the following methods.

Irreversible: Wavelet transform is said to be "irreversible" because it introduces quantization noise that depends on the precision of the decoder.

Reversible: A rounded version of the bi-orthogonal wavelet transforms. It uses only integer coefficients, so the output does not require rounding (quantization) and so it does not introduce any quantization noise. It is used in lossless coding.

Quantization: After the wavelet transform, the coefficients are scalar-quantized to reduce the amount of bits to represent them, at the expense of a loss of quality. The output is a set of integer numbers which have to be encoded bit-by-bit. The parameter that can be changed to set the final quality is the quantization step.

V. THE PARAMETERS REQUIRED BY APPLICATIONS

Lossless Compression, Visually Lossless Compression, Visually Lossy, Compression, Progressive Spatial Resolution, Progressive Quality Resolution, Security, Error resilience, Complexity Scalability, Strip Processing, Information embedding, Repetitive Encoding/Decoding, ROI Encoding/Decoding, Fast/Random Data Access.

VI. APPLICATION-WISE REQUIREMENTS OF JPEG 2000

Image type

Image width and height: 1 to (232 – 1)
Component depth: 1 to 32 bits.
No. of components: 1 to 255 (or more)
Dissimilar component depths. Dissimilar component spans (each component can have a different coverage) [6].

Internet, Digital libraries

Image sizes from 32 x 32 up to at least 4K x 4K pixels with 1, 3 (Y, RGB,YUV,…) or 4 components including alpha channel and from 1 to 8 bits/component

Printing:

Compound images, with typical sizes of 4800 by 6600 pixels (600ppi, 8in by 11in image) with 1, 3, and 4 components and 8 bits/component

Scanning:

Compound images, with typical sizes of 10K x 10K up to at least 20K x 20K pixels with 1, 3 and 4 components and up to 16 bits/component

Digital Photography:

Natural images, with sizes of at least up to 4K x 4K pixels with 1, 3 components (with spatially correlated components), with a minimum of 8 bits/component and a maximum of 16 bits/component.

Remote Sensing:

Infra-red, electro-optical, multi-spectral, hyper-spectral and SAR images, with virtually unlimited vertical definition and fixed horizontal definition depending on the line scan sensor up to 24000 pixels with 1 up to 500 components, and 8 up to 20 bits/component precision.

Mobile:

Compound images, with sizes from 32 x 32 up to at least 4K x 4K pixels with 1 or 3 components (Luminance, RGB,) and 1 to 8 bits/component.

Medical:

Natural images, with sizes from 32 x 32 to at least 10K x 10K pixels with 1 and 3 (Luminance, RGB,) or 4 components (plus alpha) and up to 16 bits/component

VII. CONCLUSION

Thus, the aim is to develop JPEG 2000 algorithm for still image coding standard for different types of still images like bi-level, gray-level, color, with different

characteristics such as scientific, medical, remote sensing, space research.

The proposed algorithm will certainly ensure the compression and de compression times reduction for low bit-rate applications, exhibiting rate-distortion and subjective image quality performance superior to existing standards.

The algorithm proposed is for advanced standardized image coding system to serve applications into next millennium and provide features vital for high-end and emerging imaging applications, provides capabilities to markets that currently do not use compression.

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