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Lossless Image Compression with Arithmetic Encoding

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Abstract—*Image compression is a process that reduces the image size and removing the unreasonable information. Shorter data size is suitable because it simply reduces cost. There are number of different data compression methodologies, which are applied to compress most of the formats. Widely used in modern image and video compression algorithm such as JPEG, JPEG-2000, H-263, CALIC. This paper deals with the image compression with arithmetic encoding. Arithmetic encoding is common algorithm used in both lossy and lossless data-compression. It is an entropy technique, in which the frequently encountered seen symbols are encoded with fewer bits than lesser seen symbols. By using arithmetic encoding high degree of adaptation and redundancy reduction is achieved.*

1. INTRODUCTION

In recent years, the development and demand of multimedia product grows increasingly fast, contributing to insufficient bandwidth of network and storage of memory device. Therefore, the theory of information compression becomes more and more substantial for shrinking the information redundancy to save more hardware space and transmission bandwidth. In computer science and manipulation of information theory, data compression or source coding is the procedure of encoding information using fewer bits or other information-accepting units than an unencoded representation. Compression is useful hence it helps reduce the consumption of expensive available resources like hard disk space or transmission bandwidth.

What is the so-known image compression coding? Image compression coding is to store the image into bit-stream as compressed as possible and to display the decoded image in the monitor as exact as possible. Now consider an encoder and a decoder. When the encoder gets the original image file, the image file will be changed into a series of binary data, which is known the bit-stream. The decoder then gets the encoded bit-stream and decodes it to form the decoded image. If the total data amount of the bit-stream is less than the total data amount of the original image, then this is known image compression.

Digital images are usually encoded by lossy compression methods due to their large memory or bandwidth requirements. The lossy compression methods accomplish high compression ratio at the cost of image quality degradation. Still, there are many cases where the loss of information or artifacts due to compression needs to be avoided, like medical, prepress, scientific and artistic images. As cameras and display systems are becoming high quality and as the cost of memory is lowered, we may also wish to hold our precious and artistic photos free from compression artifacts. Hence efficient lossless compression will become more and more important, while the lossy compressed images are usually satisfactory in many cases.

The goal of lossless image compression is to represent an image signal with the smallest possible number of bits without loss of any information, thereby speeding up transmission and minimizing storage requirements. The number of bits representing the signal is typically expressed as an average bit rate (average number of bits per sample for still images, and average number of bits per second for video). The goal of lossy compression is to accomplish the best possible fidelity given an available communication or storage bit rate capacity or to minimize the number of bits representing the image signal subject to some allowable loss of information. In this way, a much greater reduction.

2. ARITHMETIC ENCODING

The main objective of arithmetic coding is to achieve less average length of the Image. Arithmetic coding assigns code words to the corresponding symbols according to the probability of the symbols. In general, the arithmetic encoders are used to compress the data by replacing symbols represented by equal-length codes with the code words whose length is inverse proportional to corresponding probability. The occurrence probabilities and the cumulative probabilities of a set of symbols in the source image are taken into account. The cumulative probability range is applied in both

compression and decompression procedures. In the encoding process, the cumulative probabilities are calculated and the range is created in the beginning. Then the selected range is divided into sub parts according to the probabilities of the symbols. Then the next symbols are read and the corresponding sub range is selected. In this fashion, characters are read repeatedly until the end of the image is happened. Lastly a number should be taken from the final sub range as the output of the encoding process. This will be a fraction in that sub range. Therefore, the entire source image can be represented using a fraction. Arithmetic coding can handle adaptive coding without much increase in algorithm complexity. It calculates the probabilities on the fly and less primary memory is required for adaptation. Arithmetic is better suited for image and video compression

3. EXISTING SYSTEM

Among a variety of algorithm, the most widely used one may be lossless JPEG[11], JPEG- LS[12], LOCO- I [13], CACIC[14], JPEG 2000 & JPEG XR[15].

JPEG - JPEG became an international standard in 1992.JPEG is the ISO/IEC international standard 10918-1: digital compression and coding of continuous – tone still images, or the ITU-T recommendation T-81.

LOCO-I: LOCO-I (Low Complexity Lossless Compression for Images) is the algorithm at the core of the new ISO/ITU standard for lossless and near-lossless compression of continuous- tone images, JPEG-LS. It is conceived as a ―low complexity projection‖ of the universal context modeling paradigm, matching its modeling unit to a simple coding unit. By compounding simplicity with the compression potential of context models, the algorithm ―enjoys the best of both worlds. It is established on a simple fixed context model, which comes near the capability of the more complex universal techniques for capturing high-order dependencies. The model is tuned for efficient operation in conjunction with an extended family of Golomb-type codes, which are adaptively selected, and an embedded alphabet extension for coding of low-entropy image regions. LOCO-I makes compression ratios similar or superior to those obtained with state-of-the-art schemes based on arithmetic coding. Furthermore, it is within a few percentage points of the best available compression ratios, at a much drop in complexity level.

CALIC: Context-based, adaptive, lossless image codec (CALIC). The codec obtains higher lossless compression of continuous-tone images than other lossless image coding techniques in the literature. This high coding efficiency is achieved with relatively low time and space complexities. CALIC place heavy emphasis on image data modeling. A unique characteristic of CALIC is the use of a large number of modeling contexts (states) to condition a nonlinear predictor and adapt the predictor to varying source statistics. The nonlinear predictor can make up itself via an error feedback mechanism by learning from its mistakes under a given context in the past. In this studying process, CALIC estimates only the expectation of prediction errors conditioned on a large number of different contexts rather than estimating a large number of conditional error probabilities. The former approximation technique can afford a large number of modeling contexts without suffering from the context dilution problem of insufficient counting statistics as in the latter approach, nor from inordinate memory use. The low time and space complexities are also attributed to efficient techniques for forming and quantizing modeling contexts. CALIC was designed in response to the ISO/IEC JTC 1/SC 29/WG 1 (JPEG) call soliciting proposals for a new international standard for lossless compression of continuous tone images. In the initial evaluation of the nine proposals submitted at the JPEG meeting in Epernay, France, July 1995, CALIC had the lowest lossless bit rates in six of seven image classes: medical, aerial, prepress, scanned, video, and compound document, and the third lowest bit rate in the class of computer-generated images. CALIC gave an average lossless bit rate of 2.99 b/pixel on the 18 8-b test images selected by JPEG for proposal evaluation, equate with an average bit rate of 3.98 b/pixel for lossless JPEG on the same set of test images.

JPEG (Joint Photographic Experts Group) (1992) is an algorithm designed to compress images with 24 bits depth or grayscale images. It is a lossy compression method to implement algorithm. One of the characteristics that make the algorithm very flexible is that the compression rate can be adjusted. If we compress a lot, more information will be lost, but the output image size will be smaller. With a smaller compression rate we obtain a better quality, but the size of the out coming image will be bigger. This compression consists in making the coefficients in the quantization matrix bigger when we desire more compression, and smaller when we want less compression. The algorithm is established in two visual effects of the people visual system. First,peaople are more sensitive to the luminance than to the chrominance. Second, humans are more sensitive to changes in homogeneous areas, than in areas where there is more variation (higher frequencies). JPEG is the most utilized format for storing and transmitting images in Internet.

JPEG 2000 (Joint Photographic Experts Group 2000) - is a wavelet-based image compression standard. It was developed by the Joint Photographic Experts Group committee with the intention of superseding their original discrete cosine transform based JPEG standard. JPEG 2000 has higher compression ratios than JPEG. It does not tollerate from the uniform blocks, so features of JPEG images with very high compression rates. But it usually makes the image more blurred that JPEG.

Most of existing prediction methods acting in lossless compression are established on the raster scan prediction which is sometimes ineffective in the high frequency region.

4. PROPOSED WORK

- To acquire a hierarchical prediction scheme
- To propose an edge directed predictor and context adaptive model for this hierarchical scheme.
- To be specific, propose a method that can apply lower row pixels as well as the upper and left pixels for the prediction of a pixel to be encoded.
- For the compression of color images, the RGB is first converted into YCuCv by an RCT mentioned and Y channel is encoded by a conventional grayscale image compression algorithm.

5. ADVANTAGES

- Lossless Compression
- High compression ratio

6. CONCLUSION

An appropriate context model for the prediction error is also determined and the arithmetic coding is utilized to the error signal corresponding to each context. For various sets of images, it is pointed that the proposed method further reduces the bit rates equate with JPEG 2000 and JPEG-XR.

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