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Quality Assessment of Compressed Images: Survey and Discussions

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ABSTRACT
Image compression is a widely researched area with a huge amount of developed methods. According to, there are five major image categories: Monochromatic, greyscale, continuous-tone, discrete-tone, and cartoon images. Numerous methods intended for compressing the images from the first four categories have been proposed, some of them being very successful. Data compression is a fundamental and well-studied problem in engineering, and is commonly formulated with the goal of designing codes for a given discrete data ensemble with minimal entropy. In this paper we review the about image compression techniques with quality of an image and also discuss the image application and their types.

Keywords: Image compression, Image quality assessment, Lossless compression, lossy compression.

INTRODUCTION

Image compression is very important for efficient transmission and storage of images. Demand for communication of multimedia data through the telecommunications network and accessing the multimedia data through Internet is growing explosively.

With the use of digital cameras, requirements for storage, manipulation, and transfer of digital images, has grown explosively. These image files can be very large and can occupy a lot of memory. A gray scale image that is 256 x 256 pixels has 65, 536 elements to store, and a typical 640 x 480 colour image has nearly a million. Downloading of these files from internet can be very time consuming task. Image data comprise of a significant portion of the multimedia data and they occupy the major portion of the communication bandwidth for multimedia communication. Therefore development of efficient techniques for image compression has become quite necessary.

A common characteristic of most images is that the neighbouring pixels are highly correlated and therefore contain highly redundant information. The basic objective of image compression is to find an image representation in which pixels are less correlated. The two fundamental principles used in image compression are redundancy and irrelevancy. Redundancy removes redundancy from the signal source and irrelevancy omits pixel values which are not noticeable by human eye. JPEG and JPEG 2000 are two important techniques used for image compression [16].

Image compression has traditionally been one of the tasks which neural networks were suspected to be good at, but there was little evidence that it would be possible to train a single neural network that would be competitive across compression rates and image sizes. It is possible to train a single recurrent neural network and achieve better than state of the art compression rates for a given quality regardless of the input image, but was limited to 32×32 images. In that work, no effort was made to capture the long-range dependencies between image patches [14].

Image quality assessment (IQA) aims to measure the perceived visual signal quality according to its statistical characteristics and human perceptual mechanism, which is widely required in numerous image processing applications. IQA plays a vital role in guiding many visual processing algorithms and systems, as well as their implementation, optimization and verification. In particular, image compression is one of the most representative applications of IQA, which can be utilized in the rate-distortion optimization process to obtain compressed images with better visual quality at the same bit-rate level.

The traditional image compression methods mainly utilize the signal-fidelity based quality metrics, which are less correlated with human perceptual quality, *e.g.,* MAE (mean absolute error), MSE (mean square error), SNR (signal-to-noise ratio), PSNR (peak SNR) and their relatives. Although these metrics possess many favourable properties, *e.g.*, clear physical meaning and high efficiency for calculation, they severely hinder the compression performance improvement in further reducing the visual redundancies in images due to their poor consistency with human visual perception [1].

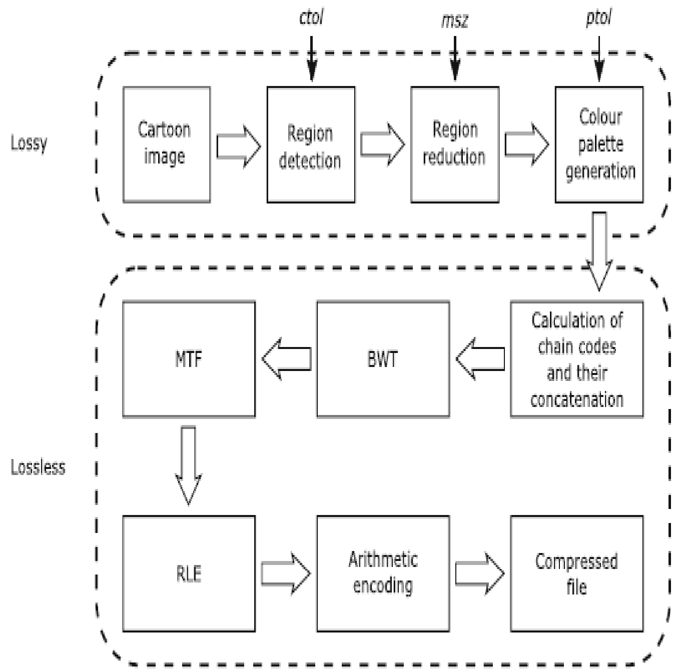

Fig 1: Steps of the compression algorithm [8].

The rest of this paper is organized as follows in the first section we describe an introduction of about the image compression and their techniques. In section II we discuss about the types of image compression methods, in section III we discuss about the related work. In section IV we present the problem statement after the rich literature review and finally in section V we conclude and discuss the future scope.

II TYPES OF IMAGE COMPRESSION

There are two types of image compression lossless and lossy. Lossless compression generates a smaller image than the original one. After decompressing we restore the original image without any data loss. On the other hand, in lossy compression we cannot recover the original image without some losses but the compressed image will be smaller size compared to lossless compression. Since lossy compressions provide much higher compression ratio than lossless compression, it is widely used in web site and network transmissions. There are many lossy

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algorithms; one of them is JPEG which introduce small image size with acceptable data loss. Many studies and algorithms have been done to introduce a lossy compression algorithm that outperforms JPEG. However, all these algorithms have a convergent performance compared with JPEG. According to the comparison in between files with deferent extensions, GIF, JPEG, PNG, RAW, and TIFF, JPEG introduces smallest file size with acceptable file quality. The standards group created by these two organizations is the Joint Photographic Experts Group (JPEG). The JPEG standard was developed over several years, and is now considered as the leading format for lossy graphics compression. Now a day the JPEG specification consists of several parts that support both lossless and lossy compression. The lossless compression produces good compression of images without the loss of any resolution. On the other hand, the JPEG lossy compression technique introduce superior compression ratio with acceptable quality.

III RELATED WORK

[1] In this paper, author constructed a large-scale image database which can be used for fine-grained quality assessment of compressed images. In the proposed database, reference images are compressed at constant bitrates levels by JPEG encoders with different optimization methods. To distinguish subtle differences, the pair-wise comparison method is utilized to rank them in subjective experiments. They selected 100 reference images for the proposed database, and each image is compressed into three target bitrates by four different JPEG optimization methods, such that 1200 distorted images are generated in total. Sixteen well-known IQA algorithms are evaluated and analyzed on the proposed database. With the devised fine-grained IQA database, they expected to further promote image quality assessment by shifting it from a coarse-grained stage to a fine-grained stage. [2] In this paper, author presented a machine learning-based approach to lossy image compression which outperforms all existing codec, while running in real-time. Their algorithm typically produces files 2.5 times smaller than JPEG and JPEG 2000, 2 times smaller than WebP, and 1.7 times smaller than BPG on datasets of generic images across all quality levels. At the same time, their codec was designed to be lightweight and deployable: for example, it can encode or decode the Kodak dataset in around 10ms per image on GPU. Their architecture was an auto encoder featuring pyramidal analysis, an adaptive coding module, and regularization of the expected code length. They also supplemented their approach with adversarial training specialized towards use in a compression setting: this enables us to produce visually pleasing reconstructions for very low bitrates. [3] In this paper, author described an image compression method, consisting of a nonlinear analysis transformation, a uniform quantizer, and a nonlinear synthesis transformation. The transforms are constructed in three successive stages of convolutional linear filters and nonlinear activation functions. Unlike most convolutional neural networks, the joint nonlinearity is chosen to implement a form of local gain control, inspired by those used to model biological neurons. Using a variant of stochastic gradient descent, they jointly optimized the entire model for rate–distortion performance over a database of training images, introducing a continuous proxy for the discontinuous loss function arising from the quantizer. Under certain conditions, the relaxed loss function may be interpreted as the log likelihood of a generative model, as implemented by a variation auto encoder. Unlike these models, however, the compression model must operate at any given point along the rate distortion curve, as specified by a trade-off parameter. Across an independent set of test images, they found that the optimized method generally exhibits better rate distortion performance than the standard JPEG and JPEG 2000 compression methods. [4]In this paper, author proposed a new approach to the problem of optimizing auto encoders for lossy image compression. New media formats, changing hardware technology, as well as diverse requirements and content types create a need for compression algorithms which are more flexible

than existing codec. Auto encoders have the potential to address this need, but are difficult to optimize directly due to the inherent on differentiability of the compression loss. They here show that minimal changes to the loss are sufficient to train deep auto encoders competitive with JPEG 2000 and outperforming recently proposed approaches based on RNNs. Their network is furthermore computationally efficient thanks to a sub-pixel architecture, which makes it suitable for high-resolution images. [5] In this paper author developed a bit allocation and rate control method that improves object detection of a DNN-based state of- the-art object detector called YOLO9000 [10]. They utilized the outputs of the initial convolutional layers of this detector to create the importance map, which is used to guide bit allocation towards regions that are important for object detection. The resulting strategy offers significant bit savings of 7% or more compared to the default HEVC at the equivalent object detection rate. For the same bit rate, the proposed strategy offers more accurate object detection and classification compared to the default HEVC.

[6] To improve the security against the chosen-plaintext attack and reduce the correlation among pixels of the encryption image, in this paper, an image compression and encryption algorithm based on chaotic system and compressive sensing is proposed by author. Firstly, the original image is permuted by the Arnold transform, and then CS is utilized to encrypt and compress the resulting image, simultaneously. Moreover, the bitwise XOR operation and the pixel scrambling method based on chaotic systems are performed on the measurements to change the pixel values and disturb the positions of pixels, respectively. Then keys used in the chaotic systems are related to the original image and generated with the SHA-256 algorithm. [8] In this paper, author introduced a new lossy approach for compression of cartoon images. The image is firstly partitioned into regions of roughly the same colour. The chain codes are then determined of all regions. The sequence of the obtained chain code symbols is transformed with the Burrows-Wheeler Transform, Move-To-Front transform, and compressed with Run-Length Encoding. In the final step, an arithmetic encoder may be used to compress the obtained binary stream additionally. The proposed algorithm is asymmetric, meaning that the decompression does not reverse all the steps of the compression procedure. The experimental results have shown that the described method produces considerably better compression ratios than JPEG, JPEG2000, WebP, SPIHT, PNG, and two of the algorithms specialised in compression of cartoon images: the algorithm using quad-tree, and RS-LZ algorithm. [11] One of the main contributions of this paper is the proposal of a novel raw plenoptic data coding architecture designed for exploiting the structure and spatial redundancy of the plenoptic data. Another contribution is the evaluation of the performances of two image coding standards (JPEG 2000 and JPEG XR) as raw plenoptic data encoder’s tools. The general objective of this research is to put into evidence what type of technologies might address the compression problem of plenoptic images acquired from modern plenoptic cameras. The particular objective, addressed in this paper, is to propose a novel algorithm for the compression of raw plenoptic data. [14] In this paper, author presents a set of full-resolution lossy image compression methods based on neural networks. Each of the architectures we describe can provide variable compression rates during deployment without requiring retraining of the network: each network need only be trained once. All of their architectures consist of a recurrent neural network (RNN)-based encoder and decoder, a binarized, and a neural network for entropy coding. They compared RNN types (LSTM, associative LSTM) and introduce a new hybrid of GRU and ResNet. They also study “one-shot” versus additive reconstruction architectures and introduce a new scaled-additive framework. They compare to previous work, showing improvements of 4.3%–8.8% AUC (area under the rate-distortion curve), depending on the perceptual metric used. [15] In this paper author concentrated on an alternative sparse representation model, i.e., the analysis sparse model, to propose a novel image

compression–encryption hybrid algorithm. The analysis sparse representation of the original image is obtained with an over complete fixed dictionary that the order of the dictionary atoms is scrambled, and the sparse representation can be considered as an encrypted version of the image. Moreover, the sparse representation is compressed to reduce its dimension and re-encrypted by the compressive sensing simultaneously. To enhance the security of the algorithm, a pixel-scrambling method is employed to re-encrypt the measurements of the compressive sensing. Various simulation results verify that the proposed image compression encryption hybrid algorithm could provide a considerable compression performance with a good security.

IV PROBLEM STATEMENT

Image quality describes the fidelity with which an image compression scheme recreates the source image data. There are four main characteristics to judge image compression algorithms

- Mean Square Error
- Peak Signal to Noise Ratio
- Compression Ratio
- Compression Speed

Mean Square Error (MSE)-Mean square error is a criterion for an estimator: the choice is the one that minimizes the sum of squared errors due to bias and due to variance. The average of the square is the difference between the desired response and the actual system output.

Peak Signal-To-Noise Ratio (PSNR)-It is the ratio between the maximum possible power of a signal and the power of corrupting noise .Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale. The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc.

Compression Ratio-The compression ratio is equal to the size of the original image divided by the size of the compressed image. This ratio gives how much compression is achieved for a particular image. The compression ratio achieved usually indicates the picture quality. Generally, the higher the compression ratio, the poorer the quality of the resulting image.

Compression Speed-Compression time and decompression time are defined as the amount of time required to compress and decompress a picture, respectively. Their value depends on the following considerations:

- The complexity of the compression algorithm.
- The efficiency of the software or hardware implementation of the algorithm.
- The speed of the utilized processor or auxiliary hardware.

V CONCLUSION AND FUTURE SCOPE

Image compression is very important for efficient transmission and storage of images. Image compression is a subject of considerable research since it attempts to ensure the image security during transmission or storage. Generally, the image compression algorithms are based on the permutation and diffusion of the image pixels. In this article we present the literature review for the image compression, many author works on the image compression but still there is problem to improve the image quality and also reduce the error, in future we overcome this problem using some neural network or optimization methods.

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