Image Compression using Various Methods: A Review

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ABSTRACT

A method of image compression eliminates unnecessary and/or irrelevant information and encrypts what remains. It is frequently necessary to discard unrelated and non-redundant data to achieve the required reduction. The subject of how to compress images and which techniques are utilized may emerge. Two types of image compression algorithms, lossless and lossy, are primarily introduced for this purpose: lossless and lossy. Currently, additional strategies are incorporated into the fundamental method. In specific applications, neural network evolutionary algorithms are utilized to compress images. This paper discussed several pictures squeezing approaches. Based on an analysis of different image compression algorithms, a survey of extant research articles is presented in this work. In this study, we examine various available picture compression methods. Compression of images differs significantly from compression of plain binary data. Use different picture compression techniques to resolve these issues.

Keywords: Image Compression; Lossless; Lossy; Sameness; Advantages of Compression.

Introduction

Image compression is lowering the size (in bytes) of a graphics file while maintaining the same level of image quality. This is accomplished without compromising the image in any way. Because of the reduction in file size, it is now possible to keep more pictures on the same number of diskettes or in the same amount of memory space. In addition, it reduces the time required for photos to be uploaded to the internet or downloaded from local network pages. An image is a physical representation or recording of visual perception. Images are crucial documents in the modern day; in order to manipulate them in various applications, it is necessary to have the compressed. Compression is greater or less it relies on our objective of the application. Image compression is very important. Crucial part in image data transfer and storage as a result of storage constraints. The primary goal of picture to compress a picture is to portray it with as few pixels as possible. bits without compromising the content's key information original image. Compression methods [1] are being rapidly created to compress huge data files, including photos. With The accelerating expansion of technology a vast quantity of images Using the right procedures, data must be stored in a proper manner. Generally, pictures can be compressed using efficient methods. There are a number of algorithms that do this compression many methods; some are lossless and others are not. Lossless maintain the identical information as the source image and lossy compression there is data loss during image compression. Several of these Compression algorithms are developed for particular types of data. Therefore, they will not be suitable for other types of photos. In some algorithms, we can alter a few parameters they employ. better adapt the compression to the image

Image compression is a method that may be utilized to improve the efficiency with which photos can be stored or transmitted. Compression is the process of lowering the size of data to represent a particular amount of information. It is accomplished through the use of digital data compression algorithms [1-3]. That example, a data set may contain redundant material that is of little value or is data that is repeated in the collection, which, if detected and can be eliminated [3]. Additionally, a data set may have data that is repeated multiple times in the collection. In the domain of images, several different types of image representation have been identified. Depending on the style that is being used, at least three different types of image representation are applied in order to reduce the amount of redundant data, eliminate redundant code, remove unnecessary pixels, and remove visual redundancy. The goal of eliminating redundant code is to use the fewest possible symbols to represent the image. For this kind of redundant code, it is common practice to employ Huffman coding compression and arithmetic coding techniques, both of which make use of statistical calculations to get rid of this kind of redundancy and reduce the amount of space occupied by the original data [1-5]. The process of encoding the original image using fewer bits is known as image compression, which is an application of data compression. The purpose of image compression is to make the image less redundant while also storing or transmitting data in a format that is as space- and time-efficient as possible [6].

This study intends to show most of the past work done by researchers as well as the results gained by experts in the field of image compression utilizing various strategies and algorithms that got the most significant developments in comparison to other compression approaches.

The remainder of the paper is laid out as follows: A Compression of Image in Section 2. Lossless and Lossy Compression Techniques in Sections 3. Review of Literature and conclusions in sections 4 and 5, respectively.

Compression of Image

Image compression solves the challenge of lowering the amount of information necessary to represent a digital image by working to make images smaller. It is a procedure with the goal of producing a more condensed representation of an image, which in turn reduces the space and bandwidth needs for image storage and transmission. Each image will contain some amount of unnecessary info.

The term "redundancy" refers to the process of duplicating data within the image. It could be a pattern that is repeated multiple times across the image, or it could be a pixel that is repeated across the entire image. The compression of the image is achieved by exploiting the image's redundant information in order to achieve the desired result. A more efficient use of an image's storage space can be accomplished by the reduction of redundant information. When one or more of these redundancies are reduced or eliminated, image compression is achieved. When compressing images, it is possible to find and take advantage of three fundamental data redundancy. The elimination of one or more of these three fundamental forms of redundant data is required in order to accomplish compression [7-10].

1- Pixel Distortion

   Neighboring pixels in a picture are not statistically independent.

   It is the result of the correlation between adjacent pixels in a picture. Inter-pixel redundancy describes this form of redundancy. Occasionally, this sort of redundancy is also referred to as spatial redundancy. This redundancy can be investigated in a number of ways, including estimating a pixel's value based on the values of its nearby pixels. Typically, this is accomplished by mapping the original 2-D array of pixels into a different format, such as an array of disparities between neighboring pixels. The mapping is reversible if the original image's [11] pixels can be recovered from the converted data collection.

2- Complexity in the Coding
Consists of making use of code words of varying length and selecting those words such that they match the statistics of the original source, which in this case would be the image itself or a processed version of the image's pixel values. This form of coding may always be reversed and is typically carried out with the assistance of lookup tables (LUTs). The Huffman codes and the arithmetic coding technique are two examples of image coding schemes that investigate the concept of coding redundancy [12].

3- Overlap in Psychological and Visual Aspects
The human eye does not respond with the same level of sensitivity to all of the incoming visual information; certain pieces of information are more essential than others. This has been demonstrated through a number of experiments that have been conducted on the psychophysical elements of human vision. This kind of redundancy is taken advantage of by the vast majority of image coding algorithms that are used today, such as the method based on the discrete cosine transform (DCT) that is at the core of the JPEG encoding standard [13].

The Benefits That Come with Image Compression

The following are some of the benefits that come with image compression [13]:

1. A reduction in file size is the most significant advantage that may be gained by using picture compression. It takes up less room on the hard disk while maintaining the same physical size, unless the physical size of the image is edited with an image editor. The reduction of file size achieved with the assistance of the internet, which enables the creation of image-rich websites while minimizing the amount of bandwidth and storage space required.
2. Data Loss:
The ubiquitous picture format JPEG, which reduces the size of an image by compressing it, throws away some of the data associated with a photograph in a way that cannot be recovered. Therefore, compress the photos and make sure that they can be decompressed successfully before you begin. If you don't do it, you will permanently lose the great quality of the original decompressed image.
3. Devices That Are Sluggish:
It may take a while for various electronic devices to load a huge compressed image. CD drives, for instance, are only able to read data at a predetermined rate, and hence are unable to display huge images in real time. In addition, some web hosts that send data more slowly may still be required for websites to have fully functional images that have been compressed. The compression of images enables a quicker download of data on devices with a lower processing speed.

Lossless and Lossy Compression Techniques

The reconstructed image that is produced by lossless compression methods, following the compression process, is numerically identical to the image that was originally created. On the other hand, lossless compression is only capable of producing a moderate level of data reduction. When an image is reconstructed after lossy compression, the quality of the image is diminished in comparison to the original. This is typically the case because the compression strategy eliminates any unnecessary information entirely. Lossy compression methods, on the other hand, are able to achieve significantly higher levels of compression. Image compression methods can be broadly divided into the two primary groups that are listed below, according to the specifications that we have outlined [14,15].

1- Lossless compression techniques

Lossless compression techniques involve compressing an image by encoding all of the information that was present in the original file.

As a result, when the image is decompressed, it will be exactly the same as the original image. Lossy compression techniques involve discarding some of the information that was present in the original file. PNG and GIF are two examples of image compression formats that do not suffer any quality reduction. When certain image compression formats should be utilized depends heavily on the content that is being compressed [14].

2- Lossy Compression Techniques

As the name suggests, lossy compression results in the loss of some of the information being compressed. The original uncompressed image and the compressed version are comparable to one another, but the compressed version is not identical to the uncompressed version since, during the process of compression [15], some information pertaining to the image was lost. Images are often an excellent fit for them. JPEG is the most typical example of a format that uses lossy compression. Lossy approaches are any algorithms that change the presentation in some way while yet maintaining the same quality as the original image. The reconstructed image is an approximation of the original image; hence, it is necessary to measure the quality of the image when using a lossy compression approach. A lossy compression method typically results in a higher compression ratio than a lossless method. Important factors affecting the performance of a lossy compression strategy include the following:

1- Compression ratio
2- Signal to noise ratio
3- The rate at which information may be encoded and decoded

Review of Literature

Lu et al. [16] suggested a preprocessing enhanced picture compression method for machine vision tasks. Instead of depending on learnt image codecs for end-to-end optimization, our system is based on typical non-differential codecs, meaning it is compliant with industry standards and can be simply implemented in real-world applications. Specifically, we propose a neural preprocessing module before the encoder to preserve semantically useful information for subsequent tasks while suppressing irrelevant information for bitrate savings. In addition, our neural preprocessing module is quantization-adaptive and may be utilized with a variety of compression ratios. In order to simultaneously optimize the preprocessing module and the machine vision tasks that follow, we introduce the proxy network for the typical non-differential codecs during the backpropagation step. We conduct extensive tests to evaluate our compression strategy for two example downstream workloads utilizing distinct backbone networks. Experiment findings indicate that our strategy provides a better balance between the coding bitrate and the performance of subsequent machine vision tasks by saving approximately 20% bitrate.

Jau-Ji Shen et al introduces classification algorithm based picture compression algorithm [17]. In this paper, they modify the encoding of the difference map between the original image, and then they restore it in a version that is VQ compressed. Its experimental results show that even though there scheme needs to provide additional data, it can significantly improve the quality of VQ compressed images, and it can further be adjusted depending on the difference map from lossy compression to lossless compression. This is shown by the findings of the study's experiments.

The technique to lossless picture compression using the innovative notion of image folding was presented by Suresh Yerva et al [18]. Folding the image is the novel concept. For the purpose of prediction, this method that has been proposed makes use of the concept of adjacent neighbor redundancy. In this technique, the image undergoes column folding, then row folding, and this process is repeated repeatedly until the size of the image is reduced to a value that has been previously determined. Comparisons are made between the suggested method and the existing standard lossless image compression algorithms, and the findings reveal that the two methods have comparable performance. In comparison to the SPIHT methodology, which is the industry standard for lossless compression, the Data Folding Technique for compression is a straightforward method that not only achieves good compression efficiency but also has a lower level of computational complexity.

The five module approach is a revolutionary method for picture compression that was presented by Firas A. Jassim, along with his colleagues (FMM). Converting every pixel value in each of the 8x8 blocks [18] into a multiple of 5 for each of the RGB arrays is what this method entails. After then, the value could be split by 5 to obtain new values. These new values would have a bit length for each pixel, and they would take up less storage space than the original values, which had 8 bits. This paper illustrates the possibilities of FMM-based picture compression algorithms by demonstrating their use. This approach has a number of benefits, one of which is that it offers a high PSNR (peak signal to noise ratio), despite having a low CR (compression ratio). This approach is suitable for bi-level images, such as black-and-white medical pictures, because each pixel in those kinds of pictures is represented by a single byte (8 bit). In subsequent study, it might be possible to build a variable module method $(X)\,MM$, where X can be any number. This would serve as a recommendation.

To overcome the image compression problem, Zhang et al. [19] suggested a new image compression approach based on residual networks and discrete wavelet transform (DWT). The codec network is composed of the residual networks. To train the network, we also introduced a unique loss function called discontinuous wavelet similarity (DW-SSIM) loss. Because picture edge information is exposed through DWT coefficients, the suggested network can learn to better maintain image edges. Experiments demonstrate that the suggested method outperforms the competing methods in terms of peak signal-to-noise ratio (PSNR) and structural similarity (SSIM), especially at low compression ratios. The noise robustness of the suggested technique is also demonstrated by tests conducted on images tainted by noise.

Rahman et al. [20] decided to conduct an in-depth study on the picture compression methods that are the most widely employed. We gave a comprehensive review of run-length, entropy, and dictionary-based lossless picture compression techniques, together with a standardized numerical example for the purpose of making comparisons more easily. After that, a discussion of the most cutting-edge approaches is presented based on a few photographs that serve as benchmarks. In the end, we measure the effectiveness of the state-of-the-art approaches by utilizing conventional measures such as average code length (ACL), compression ratio (CR), pick signal-to-noise ratio (PSNR), efficiency, encoding time (ET), and decoding time (DT).

Yi-Fei Tan, et al [21] use reference points coding with threshold values to compress images. This work proposes a lossy-and-lossless image compression method. Variable threshold values can produce varied compression ratios, and lossless compression is accomplished if the threshold is set to zero. The suggested approach determines image quality during compression. Then If a recommended method's threshold value is 0, lossless compression is used. Positive threshold values produce lossy compression. Further research can determine the ideal threshold T.

Dharanidharan et al. [22] provided a novel modified international data encryption algorithm to encrypt the whole image securely after the original file is segmented and transformed. Using the Huffman method, segmented image files are blended into a single image. They finally decipher the image. Next, they transport encrypted images to multipath routing. The above-compressed image was transmitted to a single pathway, and they now use a multipath routing strategy to generate a dependable, efficient image.

An implementation of multiwavelet transform coding for lossless image compression is described by K. Rajkumar et al [23]. The performance of the IMWT, also known as the integer multiwavelet transform, for lossless was explored in this article. The IMWT yields satisfactory results when applied to the reconstructed image. The performance of the IMWT [17] for lossless compression of images using magnitude set coding has been obtained in the current paper. In the method that has been suggested, the transform coefficient is encoded using a methodology that employs both a magnitude set of coding and a run length encoding method. An investigation of the effectiveness of the integer multiwavelet transform for the lossless compression of image data was carried out.

A brand new method for the encryption and compression of images has been proposed by Rengarajaswamy et al [24]. Stream cipher is used in this method for the purpose of encrypting an image, and then SPIHT is utilized in order to compress the image. Stream cipher encryption is carried out in this paper to provide better encryption than is currently being employed. SPIHT compression offers superior compression since the size of larger images can be selected, and the compressed image can be decompressed with minimum to no loss in quality of the original. Therefore, a high level of encryption that is kept confidential as well as the best possible compression rate have been activated to ensure improved safety. This fulfills the primary objective or goal of this study.

Padmaja et al. [25] explored various picture compressing algorithms. In addition to this, particular ways that illustrate how such techniques might be used in real-world photos are described in this article. Several stages of the overarching process of compressing pictures have been discussed in this guide section. The fundamentals of image coding were covered, including a review of vector quantization and one of the primary techniques of wavelet compression that can be used with vector quantization. This analysis of different compression methods provides expertise in identifying the beneficial qualities and assists in picking the appropriate way for compression.

The topic of image compression is discussed by Sonal et al. [26] in light of its applicability to a variety of subfields within image processing. This paper introduces the Principal Component Analysis approach to image compression after reviewing and analyzing the many current image compression techniques. The evaluation and analysis of these techniques can be found in the Background section. The PCA approach can be carried out in two distinct manners: the PCA Statistical Approach and the PCA Neural Network Approach. It also covers a variety of positive aspects associated with the utilization of picture compression methods.

The quality of the compressed image has been improved thanks to UmaMaheswari et al. [27] When it comes to image compression; a medical image can be processed to a significant depth via de-noising, edge preservation, and a high compression rate. This study aims to design a computational tetrolet transform that is both effective and efficient and also suitable for lossless data compression. To perform analysis, several different wavelet approaches are utilized, and the results are compared with the methodologies. Based on the research findings, it can be deduced that the proposed technique has the potential to produce images of high quality and low noise.

Arwa et al. [28] assessed the most common approaches and methods of image compression, with a particular emphasis on auto-encoders for deep learning.

Mishra et al. [29] examined over a hundred cutting-edge algorithms that primarily utilize lossy picture compression and deep learning architectures. The designs of these deep learning algorithms include CNN, RNN, GAN, auto encoders, and variational auto encoders. We have grouped all algorithms into certain groups for more excellent and more thorough comprehension. The review is composed of the contributions of researchers and the issues they encounter in mind. Numerous results for the researchers and future directions for new researchers have been emphasized in detail. Most of the reviewed articles in the compression domain are from the last four years and employ various approaches. The review has been summed up by presenting a new perspective for image compression researchers.

Conclusion

Several different methods of image compression are discussed in this article. These issues continue to be a difficult challenge for the researchers and academicians. The majority of picture compression methods can be categorized into one of two categories. It is difficult to compare the performance of different compression techniques unless the data sets and performance measures that are being utilized are equivalent. Certain applications, notably those dealing with security technology, can make effective use of certain of these strategies. Following an analysis of each method, it was discovered that the strategies for lossless image compression are superior to the techniques for lossy image compression in terms of efficiency. Lossy compression results in a greater ratio than lossless compression.

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