Software Engineering
2018; 6(4): 116-120
http://www.sciencepublishinggroup.com/j/se
doi: 10.11648/j.se.20180604.12
ISSN: 2376-8029 (Print); ISSN: 2376-8037 (Online)

Review Article

The Application of Selective Image Compression Techniques

Ikerionwu Charles*, Isonkobong Christopher Udousoro*

Department of Information Technology, School of Computing and Information Technology, Federal University of Technology, Owerri, Nigeria

Email address:
charles.ikerionwu@futo.edu.ng (I. Charles), isonkobongudousoro@gmail.com (I. C. Udousoro)

*Corresponding author

To cite this article:
Ikerionwu Charles, Isonkobong Christopher Udousoro. The Application of Selective Image Compression Techniques. *Software Engineering*. Vol. 6, No. 4, 2018, pp. 116-120. doi: 10.11648/j.se.20180604.12

Received: December 9, 2018; **Accepted**: December 22, 2018; **Published**: January 16, 2019

Abstract: The limited available storage and bandwidth required for successful transmission of large images make image compression a key component in digital image transmission. Digital image application in various industries, such as entertainment and advertising, has brought image processing to the fore of these industries. However, the entire image processing is faced with the problem of data redundancy, which is mitigated through image compression. This is simply the art and science of reducing the number of bits/data of an image before it is transmitted and stored easily while the quality of image is maintained. Thus, through an exploratory study, this paper examines image compression as discussed in extant literature and emphasises on different methods used in image compression. The paper reviewed relevant literature from Elsevier, Emerald, IEEE, ProQuest and Google scholar databases. Specific methods are lossy and lossless techniques, which are further divided into run length encoding, and entropy encoding. In conclusion, the paper recommends compression techniques to adopt depending on the industry's' goals. Preferably, lossy compression is used to compress multimedia data which includes audio, video and images, while lossless compression technique is used to compress text and data files.

Keywords: Image Compression, Lossy Technique, Lossless Technique, Transform Coding Encoder and Decoder

1. Introduction

Digital images are made up of pixels which stand for a certain colour in any image. Digitization of an image is the measurement of the colour at many points. Pixels are organized in forms of an array (rows and columns) which makes up a two-dimensional image [1]. Due to the improvement of technology and digitization, simplicity has been introduced into the process of capturing, storing and transferring of images with the help of digital cameras. These digital cameras produce images that are instant – i.e., they are processed immediately. These images are developed from digital cameras and could be large, but the process of sharing or transmitting these images have been a major obstacle. In addition, preservation of the raw data (image) for future processing is faced with issues such as the size of the storage facility and transmission media [2]. To solve these problems, image compression is applied to reduce the size and preserve its original quality. Thus, image compression is a technique used to reduce or compress the number of bits in an image for easy transfer and storage. The major objective of image compression is to reduce redundancy of the image while the quality of the image is still maintained [3]. A successful image compression focuses on removal of redundancies that include interpixel (formed from correlation between image pixels), coding (when less optimal code words are applied), and psychovisual (data that the human eyes cannot visualise) redundancies.

For example, figure 1 presents a block diagram of step by step process of image compression. It comprises of two sections encoder and decoder. When an image, say, f(x, y) is fed into the encoder, it creates a set of symbols from the data

which represents the image. Let n1 and n2 represent these inputs and Cr is the compression ratio, which is calculated thus:

$$Cr = \frac{x1}{x2} \quad (1)$$

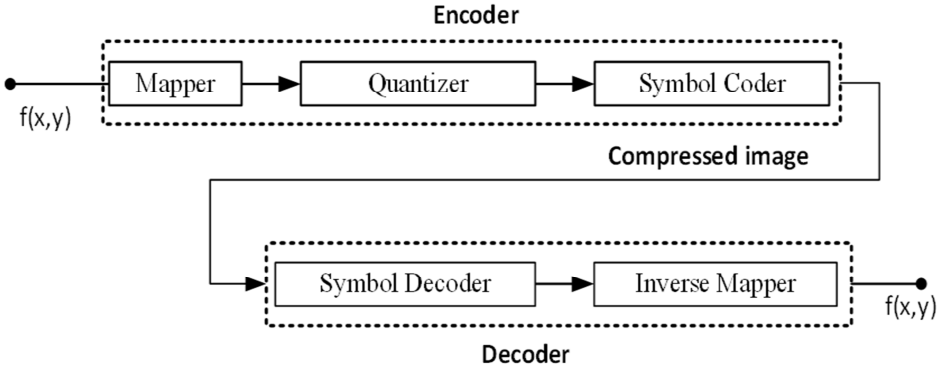

Figure 1. *Image compression framework.*

Primarily, image compression techniques are classified into two categories, which are lossy compression and lossless compression techniques [2]. When compressing image with lossless image compression technique, the quality of the image is like the original image. This technique is mostly used in the medical field, technical drawing or comics. In a lossy image compression technique, the image is devalued, which means that some data is lost from the original image. It reduces the file permanently by eliminating redundant information. Lossy technique has found its application in video and sound compression where loss of information would not be detected by the user. Although lossy technique leads to the devaluation of the original image, most often, lossy compression technique is preferred to lossless compression technique when the file is not large.

2. Related Works

Various techniques have been developed and suggested for image compression by different authors. Most of which are still in use in today's image processing community. The merging of discrete cosine transform (DCT) and discrete wavelet transform (DWT) methods to arrive at a better compression ratio mostly used to compress medical images is one of the techniques [4]. This method is first achieved by converting the RGB image into Y,Cb,Cr (where Y= luminance component; Cb = chroma blue difference; Cr = chroma red difference) before the discrete wavelet transform is combined with discrete cosine transform and applied to get a compressed image.

A hybrid image compression technique for storage and transmission was suggested by [5]. It is based on three algorithms, which includes daubechies-4 wavelet transform, lifting wavelet transform and entropy encoding. These algorithms are applied when the image is first changed to luminance and chrominance components. The proposed hybrid compression significantly improved the compression ratio, bits per pixel and peak signal to noise ratio. Normally, JPEG standard technique for image compression reduces the size of the image, however, [6] developed an improved version by combining the JPEG algorithm and Symbol Reduction Huffman technique. Firstly, the image is converted to gray scale before Discrete Cosine Transform, and then undergoes zigzag ordering. Then, entropy encoder is applied to the gray scale image for compression. This process applies quantization to the combined Discrete Cosine Transform and Discrete Wavelet Transform on the image colour i.e., Y, Cb, Cr and its subsequent compression [7].

Discrete Wavelet transform can also be a standalone technique for image compression. This can be combined with Ridgelet compression methods to get a compressed image [8]. In this method or technique, the image is first converted to gray scale before Discrete Wavelet and ridgelet transform is then applied for compression, this is regarded as lossless image compression technique. Binary Coding and Feature extraction methods are applied to an image that has been resized and converted to gray scale to compress the image as proposed [9]. Irrespective of the method adopted for image compression, the first step is to resize an image to 256 * 256 before any method of compression is applied. Using Modified Fast Haar Wavelet Transform (MFHWT) and Singular Value Decompositions (SVD), an image could be converted to gray scale and then compressed [10]. This method also requires the introduction of Hybrid Wavelet Transform to get the approximations and coefficients.

In compression of an image, to get a better compression ratio, [11] suggested the combination of Discrete Cosine Transform and Discrete Wavelet Transform. However, the introduction of Set Partition in Hierarchical Tree (SPIHT) combined with Hyper Analytical Wavelet (HWT) is set to give a higher compression ratio and maintain image quality [12], but [13] came up with the combination of Hybrid Transform, Set Partition in Hierarchical Tree (SPIHT) and Block based seam carving algorithm for greater compression ratio. The introduction of neural network reduces the compression ratio of any image. Findings by [14] suggest the combination of neural network with Wavelet transform for better compression ratio of images. In conclusion, every method introduced aims to reduce compression and improve image quality.

3. Method of Investigation

The study reviewed a total of two hundred and twelve journal papers published in reputable academic journals spanning from 2005 to 2018. During the search, the scope was limited to the keywords "image compression techniques" and those papers with these keywords were reviewed. The search was performed in databases such as IEEE, Elsevier, ProQuest, and Emerald publishing. Table 1 presents the distribution of the searches in the number of papers and its contributing percentage to the total number of papers reviewed. The researchers reviewed each paper and discussed respective image compression techniques used in the various journal papers.

Table 1. *Distribution of reviewed papers.*

S/no	Database	Number of papers	Percentage
1	Google Scholar	78	37%
2	IEEE	32	15%
3	ProQuest	32	15%
4	Elsevier	38	18%
5	Emerald	15	15%

4. Classification of Image Compression Techniques

This section discusses different extant techniques used in image compression as it affects different applications.

4.1. Lossless Compression Technique

In this type of technique, the image looks the same with the original image after compression. This technique is also known as reversible technique as the image that is compressed can also be reversed to the original image. The compression ratio in lossless technique is low. Because of this, its applications are found in text documents and file formats. This technique is also known as noiseless compression technique as it does not produce any noise when and after compression. Other applications are found in medical imaging and technical drawing. Figure 2 demonstrate an applicable algorithm used in lossless compression technique.

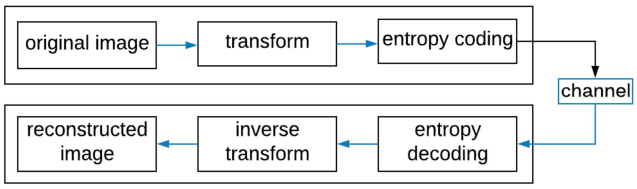

Figure 2. *Lossless Compression Technique [4].*

Some of the methods that are used in carrying out lossless compression include:

i. Run Length Encoding: This is one of the simplest method of lossless image compression. Run length is known as the number of successive pixels that have the same values. This method is very important when it comes to data that is repetitive. It replaces pixels or symbols that are the same or identical known as runs with much shorter symbols. The basic idea behind this method is to replace symbols or pixels that are repeated with one occurrence which is followed by the number of the occurrence. For example:

Original Data AAAACCCDDDDDYYYYYY.

Compressed Data A4C3D5Y6.

This technique or method is mostly supported by bitmap file formats. The compression ratio is one of the disadvantages of this method as other methods or techniques reach a higher compression ratios compared to the Run length encoding, but this method is easy to implement and quick to execute, which gives users the options of using it or leaving it uncompressed. This technique is most useful and successful when compressing bi-level images since the occurrence of a long run of a value is rare in ordinary gray scale images.

ii. Entropy Encoding: This is another lossless technique compression that involves creating a unique prefix code which is then assigned to a unique symbol in the input. This technique is different from the Run length encoding because it compresses data by replacing the fixed length output with a prefix code word [15]. Several entropy coding methods are known which include:

1. Huffman Coding: This code is a prefix code which assigns shorter codes to the symbols that occurs more frequently and then assign longer codes to those that occur less frequently. These codes are being stored in code book. The basic function of this method is to use lower number of bits to encode the data that occurs more frequently. This method was developed by David A. Huffman.

2. Arithmetic Coding: This method doesn't use several bits for each symbol to compress data with a single code rather neighbouring pixels are being used for correlation. The major disadvantage of this method is its low speed. While the main objective of this method is to assign each symbol an interval.

iii. Area Encoding: In this method, the image is segmented or divided into different blocks, these segments contains either black pixels or white pixels or mixed intensity of black and white. Another approach of the area encoding is to use an iterative approach in which the binary image is decomposed into smaller blocks where a tree is built for it in a hierarchical form. When all the pixels in the blocks have reached the same value then the image has been an advanced Run Length encoding method.

4.2. Lossy Compression Technique

This technique is also known as irreversible compression technique as the compound image cannot be reversed to its original image. This technique subtracts unwanted bits of information and data and rearranges it, so that the file becomes smaller and compressed. Lossy compression techniques is mostly used to reduce the size of bitmap pictures which are very large. The compression ratio is higher in lossy compression technique compared to lossless compression technique. The lossy compression framework is shown in figure 3. Firstly, the original image passes through four stages, i.e., decomposition, quantization, modelling and encoding, and finally compressed image. Through this process, the

image losses some size of the original form while retaining its original quality, but in a compressed form.

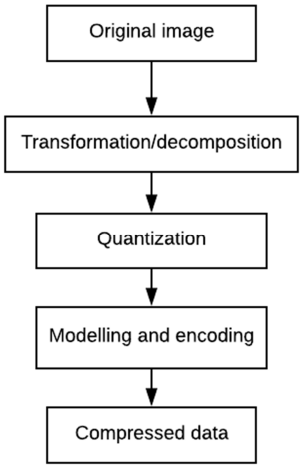

Figure 3. *Lossy compression framework.*

As a schematic process of compressing images, lossy technique could be applied using any of the following methods:

i. Chroma subsampling: The human eye is very sensitive to the changes in brightness of images more than the color differences associated with it. Therefore, this method takes advantage of the human eye by dropping or reducing the chrominance information of the image while increasing the luminance data. It uses this technique to reduce or compress the image to a lower resolution while keeping the original image quality.

ii. Transform coding: This technique is involved in compressing natural data, which are photographic images to either lossy or lossless process. In a lossless process, the image is reversible, but the advantage is that it provides better quantization of the image. Its process converts images to transform coefficient values which results in a low resolution or quality output. No information is lost which brings about equality in the number of coefficients and number of pixels transformed. The coefficients are quantized and the output is used by a technique from symbol encoding to produce the final output.

iii. Fractal coding: This method is mostly applied to textures and natural images where parts of this image are being converted to mathematical data known as fractal codes which are then used to create the encoded image. When this happens, the resolution of the image is lost which makes it resolution dependent. The degradation of the image is attributed to the poor self-similarity index of the input image [16].

5. Conclusion

In this paper, forms of image compressions are discussed, which highlighted on the process and different image compression techniques. Specifically, these techniques are divided into two categories - lossy image compression and lossless image compression techniques. In lossy technique, the derived image that is decoded tends to lose information after compression. It is irreversible, results in loss of data and image quality. In lossless compression, information is not lost after compression. Various methods have been discussed under lossless and lossy compression techniques, which include run length encoding, entropy encoding, transform coding etc. Lossy compression technique is mainly used to compress multimedia data which include audio, video and images while lossless compression technique is used to compress text and data files. Thus, this study recommends the use of either lossy or lossless method of image compression based on the user's specific application need. In either way, images are compressed to a smaller size which allows for faster transfer and reduced storage size.

References

[1] Ramírez, J. (2012). Images and society (or Images, Society and its Decoding). Athenea Digital. Revista De Pensamiento E Investigación Social, 12(3), 217. doi: 10.5565/rev/athenead/v12n3.1081.

[2] Singh, M., Kumar, S., Singh, S. & Shrivastava, M. (2016). Various Image Compression Techniques: Lossy and Lossless. International Journal Of Computer Applications, 142(6), 23-26. doi: 10.5120/ijca2016909829.

[3] Balaso, Y. V. (2016). Image Compression Techniques. International Journal of Engineering Technology and Computer Research, 4(1).

[4] Mohammad, I. & Zekry, A. (2015). Implementing Lossy Compression Technique for Video Codecs. International Journal of Computer Applications, 131(7), 44-51. doi: 10.5120/ijca2015907421.

[5] Banu, S. P. & Venkataramani, D. Y. (2011). An efficient hybrid image compression scheme based on correlation of pixels for storage and transmission of images. International Journal of Computer Applications (0975–8887) Volume, 6-9.

[6] Kumar, B., Thakur, K., & Sinha, G. R. (2012). A new hybrid JPEG symbol reduction image Compression technique. The International Journal of Multimedia & Its Applications, 4(3), 81.

[7] Sriram, B., & Thiyagarajan, S. (2012). Hybrid transformation technique for image compression. Journal of theoretical and applied information technology, 41(2).

[8] Jasmine, K. P., Kumar, D. P. R. & Prakash, K. N. (2012). An Effective Technique to Compress Images Through Hybrid Wavelet-Ridgelet Transformation. International Journal of Engineering Research and Applications (IJERA) ISSN, 2248-9622.

[9] Sumithra, M. E. P. D. M. (2013). Medical image compression using integer multi Wavelets transform for telemedicine applications. International Journal Of Engineering And Computer Science, 2(05).

[10] Chaudhary, M., & Dhamija, A. (2013). Compression of Medical Images using Hybrid Wavelet Decomposition Technique. International Journal of Science & research (IJSR). India Online, 2(6).

[11] Bansal, N. (2013). Image compression using hybrid transform technique. Journal of Global Research in Computer Science, 4(1), 13-17.

[12] Reddi, D. P., Prasad, M. G. & Varadarajan, S. (2013). A New Image Compression Scheme Using Hyperanalytic Wavelet Transform and SPIHT. Contemporary Engineering Sciences, 6(2), 87-98.

[13] Reny Catherin, L., Thirupurasunthari, P., Sherley Arcksily Sylvia, A., Sravani Kumari, G., & Joany, R. M. (2013). A Survey on hybrid image compression techniques for video transmission. International Journal of Electronics and Communication Engineering, 6(3), 217-224.

[14] Tang, J., Deng, C., Huang, G. B., & Zhao, B. (2015). Compressed-domain ship detection on spaceborne optical image using deep neural network and extreme learning machine. IEEE Transactions on Geoscience and Remote Sensing, 53(3), 1174-1185.

[15] Theis, L., Shi, W., Cunningham, A. & Huszár, F. (2017). Lossy image compression with compressive auto encoders. arXiv preprint arXiv:1703.00395.

[16] Zou, K., Wang, Q. & Zhai, Z. (2015, October). A novel method to improve the quality of decoded images in fractal image coding. In Image and Signal Processing (CISP), 2015 8th International Congress on (pp. 184-188). IEEE.