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Comparative Analysis of Image Compression Using Huffman and DCT Method on JPG Image

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Abstract: Today, the information exchange has become faster than before. The speed of an information exchange is given by the smallest data sent. The compression method is the solution for making the information smaller than before. The information we discuss in this study is an image data. The image compression is one of the multimedia field which is used by people from past until now, even forever. The purpose of the image compression is to make the size of the image smaller than the original image size. The image compression has several methods, these are Huffman, DCT, DWT, LZW, EZW and much more. The image, we use for the experiment is JPG format. We will use three images for the sample. In this study, we compare the compression size and the compression ratio using Huffman and DCT methods.

Key words: Image compression, Huffman, DCT, DWT, JPEG, JPEG2000

INTRODUCTION

An image compression is important to make an efficient transmission and to save the memory on storage. In this modern era, the camera technology becomes more advanced on taking a photo, so, the picture result will be had high size and has high frame or pixel. The grayscale picture with 256×256 pixel will be had 65,536 elements to saving on the storage. The RGB or true color image with dimension 640×480 pixel will have color almost 1 million (Jasmi *et al*., 2015).

The efficient compression techniques are very important because of that problem. The main purpose of image compression is to find an image representation which has a correlation between pixel has reduced. The image compression has two basic standards which the first standard is redundancy and the second standard is irrelevant between pixel (Patel *et al*., 2016). The redundancy standard function is to remove the redundancy from the source signal and remove the wrong pixel number which unseen by human eyes. The important image compression standard techniques are JPEG and JPEG2000 (Juma'in, 2011).

The image problem today is bigger size needed to save the image because the taken picture size will use more storage space when we want to save it into storage, especially with this smartphone with high-resolution camera era. If we want to send the taken picture over bandwidth, it will be slower than before. The image compression has two basic techniques, the first technique is lossless compression and the second is lossy compression. Lossless compression is a technique which process the original data and change it into more efficient data without losing any information, meanwhile the lossy compression is a technique which process the original data and change it into more efficient data with several approximates process from the original data but it can have several errors and can't change it back into the original size (Krasmala *et al*., 2017).

We will use Huffman and DCT methods in this experiment paper to compress 3 different images as the sample for the experiment. Each picture has different size but with the same format (.jpg). The benefit of image compression is: the file become smaller size, the file is easier to send it over bandwidth, the computer storage will have more free space and we can save another priority thing to the storage (Phakade *et al*., 2014).

MATERIALS AND METHODS

Image: An image is a representation data from an object or a thing which has a continuous function from light intensity on a dimension (1-3 Dimension). An image has several outputs form, these are: analog, this will happen when the picture as a video signal, digital, this will happen when the picture wants to save it into a disk (compact disk), optic, this will happen when we take it as a photo. The image can be grouped into two kinds, these are:

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Physic image, this image means is like an image or a photo, not physic image, this image mean is like a file which represented into a mathematic function or a matrix (Panda and Swain, 2017).

Compression: Compression on an image is a method, a technique or a process for an image with the purpose to reduce the picture size and remove the redundancy, so that, the picture can be saved or send it over an internet bandwidth very efficient. The redundancy information from the image must be compressed to fulfill the purpose of the image compression. This compression can do with any image format with any exists methods (Vaish and Kumar, 2014).

The main purposes from digital image compression is to reduce the image size and reduce the used memory, so that, it will be easier to save it into storage, processing the image and sending the image to others. We must remember that the image compression main purposes are to remove the redundancy, reduce the image size but doesn't affect the image quality. But we must remember too that there are several methods can affect the image quality.

Saving the image data purposes are to prevent or avoid any damaged or losing data on the image when we want to send it to another or when we want to save it into storage. Computer storage has limitation to save data. So with this compression technique, we can save from the storage limitation of the computer storage (Babu *et al*., 2013).

Lossless compression: This lossless compression technique is one kind of output from the image compression. This technique will decompress the data given from compression and will get the same size with before compression or the original data. This technique will make the image wouldn't losing any information from the compression. This technique usually used for medics.

This technique is needed when the user wanted to have the same size of the image after the compression and the decompression process have done. GIF format and PNG format is the example of this technique (Arif *et al*., 2012).

Lossy compression: This lossy compression technique is another kind of output from the image compression. This technique will compress and change the detail and change the color in image become simple than the original image. So, the size can be more reduced without affecting the image.

This technique can make the file will have smaller size than lossless techniques and still used until now. This technique usually removed the useless data from the image, so, the resulting image will not change too far from the original if, we just see it with our eyes (Panda and Swain, 2017).

Huffman coding: In 1952, there is a man named David Huffman. He is a college student of MIT. He found and create a method named Huffman coding using a binary tree to look for an efficient code. Physically, an image is a set of many data and a representation from many objects and create a dimensional image.

In this world, image dimension has two kinds, the first is two dimension (2Df(x, y)) and the second is three dimension (3Df(x, y)). The "x" and the "y" is represented of the coordinate 2D or 3D. Meanwhile, the "f" represents the intensity value (brightness) or represent the color for each dimension (2D/3D) (Sikka *et al*., 2016).

Digital image on a computer is only 2D where all the image matrix called pixel and every set of matrix element will show the image color or intensity. The grayscale matrix will show the grayscale level of an image.

Huffman method is one kind of image compression lossless technique. The image will be encoded based on the grayscale level or color level from many pixels in the image. From that, we can know that Huffman method is a statistical compression on the image compression (Oliver and Malumbres, 2006).

Discrete cosine transform: Discrete cosine transform is transformation method to change the signal from the spatial domain into a frequency domain. The DCT transformation can make the data more efficient. The DCT transformation makes the image data needed reduced to represent an image (Hnesh and Demirel, 2016).

The DCT has two dimensions of the image to compress, these are 1-D DCT and 2-D DCT. For the equation between the dimension will be shown as. The 1-D DCT equation that usually used is in Eq. 1 and 2. The 1-D DCT equation:

$$G_f = \sqrt{(2 \wedge n)} C_f \sum\nolimits_{-}(t=0)\hat{}(n-1) P_t \cos\left[(2t+1)f\pi/2n\right]$$

$$P_t = \sqrt{(2/n)} \sum\nolimits_{-}(j=0)\hat{}(n-1) C_j G_j \cos\left[(2t+1)f\pi/2n\right]$$

$$\text{for } t = 0, \ldots, n-1 \quad (1)$$

where, C_f= {(1/√(2)@1)-| (for f = 0)|(for f>0) for f = 0, 1, …, n-1. The main advantage when we use 1-D DCT is located on the system which it will take the correlation between the data inputted and focus on the first coefficient. The

first coefficient usually contains the most amount of data information between the other coefficient, so, we can say this 1-D DCT method is focused on the first coefficient only (Juma'in, 2011). The 2-D DCT equation that usually used is in Eq. 3. The 2-D DCT equation:

$$C(u,v) = D(u)D(v)\sum\_ (x = 0)\^(n-1) \sum\_(y = 0)(n-1)(f(x, y)\cos) \left[(2x+1)u\pi / 2N\right]\cos\left[(2y+1)v\pi/2N\right] \quad (2)$$

where, U and V = 0, 1, 2, 3, ..., N-1. The inverse of 2-D DCT equation:

$$F(x,y) = \sum\_x = 0\^(N-1)\sum\_y = 0\^(N-1) D(u)D(v)D(u,v)\cos[(2x+1)u\pi/2N] \cos[(2y+1)v\pi/2N] \quad (3)$$

where, D(u) = (1/n)1/2 for U = 0. Where D(u) = (2/n)1/2 for U = 1, 2, 3, …, (n-1). The DCT technique, these are several steps to compress the image data. The steps are: DCT transformation, quantization, entropy encoding. These processes will be described in this study.

DCT transformation: The transformation will be success if we can transform the image while we use lower coefficients. In this study, the input image will be transformed into a format to reduce the redundancy between the pixel. The transformation technique used to use is reversible and transformation mathematic linear to connect between pixel into the coefficient. The next step after transformation is quantization and then encoding (Singh and Rana, 2012).

Quantization: The quantization process purpose is to remove the unnecessary coefficients on the DCT to reconstruct the resulting image. The removed thing is the coefficients which contain high frequency because it will affect the resulting image. The next step is encoding (Singh and Rana, 2012).

Entropy encoding: The entropy encoding process is where the final matrix without high-frequency coefficients will eliminate the matrix with "0" and will be encoded using encoding algorithm (zig-zag, LZW, EZW and much more). After the encoding process is done, we can say that the resulting image is the compression image result.

RESULTS AND DISCUSSION

The comparative experiment between Huffman and DCT will be described in this study. The image compression process will be shown in the compression flowchart which given in this study. The following process it just a compression process without decompressing it back into the original file. The compression process is when the program will process the inputted image and will compress it into the compression result.

For the source data, we can see the original size before compression it in Table 1. The flowchart of the process will be shown after we show the original file which we use for this experiment and we compress it using DCT and Huffman.

The flowchart told us about the how the system works. The first step is we will input our image into the system. The second step is the system will check if the image is a RGB image or not. If the image is a RGB image, the system will compress the image and finish it. If the image is not a RGB image, the system will reject and asked the RGB image before compressing the image. The third step is compressing the image and save it into our storage (Shukla and Gupta, 2015).

Figure 1 which has compressed by Huffman method and by DCT method. There will be shown the original image and the image compressed meanwhile the table will be shown after the image after compressed shown.

The original image shown in Fig. 2 with image size is 45.4 kB, the Huffman compressed image result shown in Fig. 3 with image size is 20 kB and become a grayscale image, the DCT compressed image result shown in Fig. 4 with image size is 14.9 kB and become a grayscale image. The original image and the compressed image in Fig. 1.

From Fig. 2- 4, we can see the differences between the original image and the compressed image by Huffman or by DCT method. We can see the original image size and the compressed mage size in Table 2-4. We can see from Table 2 that all the samples are using jpg format with different image size.

From Table 3, we can make a graphic from the differences between the original image and the

Table 1: The original image data

File names	Image size (kB)
ck.jpg	45.4
Ck2.jpg	299.0
Diablo.jpg	207.0

Table 2: The original image table

File names	Image size	Format
ck.jpg	45.4	.jpg
ck2.jpg	299.0	.jpg
Diablo.jpg	207.0	.jpg

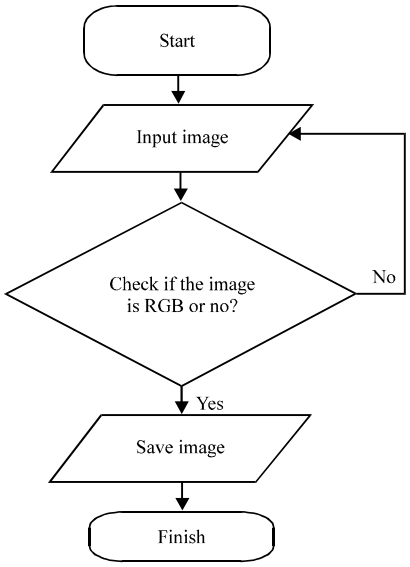

Fig. 1: The program flowchart

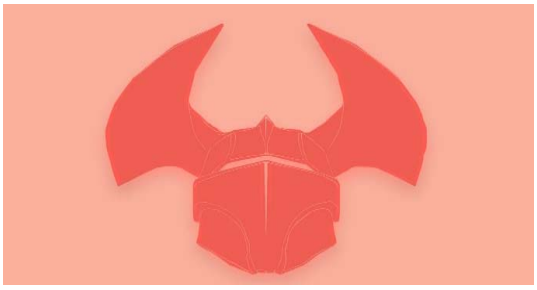

Fig. 2: The original image of ck.jpg

Fig. 3: The compressed image by Huffman method

Table 3: The Huffman compressed image table

File names	Image size (kB)	Compression size (kB)	Ratio (%)
ck.jpg	45.4	20	56
ck2.jpg	299.0	41	86
Diablo.jpg	207.0	26	87

Table 4: The DCT compressed image table

File names	Image size	Compression size	Ratio (%)
ck.jpg	45.4	14.9	67
ck2.jpg	299.0	73.9	75
Diablo.jpg	207.0	47.2	77

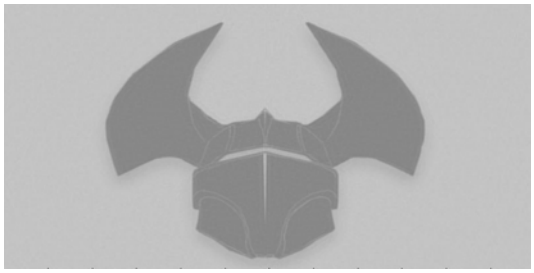

Fig. 4: The compressed image by DCT

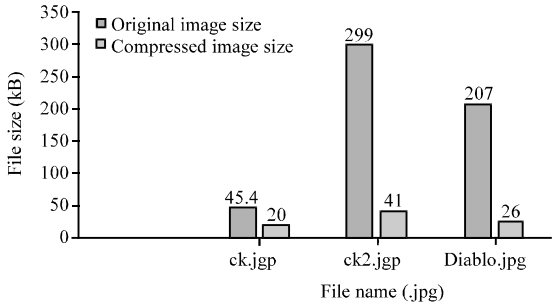

Fig. 5: Graphic from compression using Huffman method

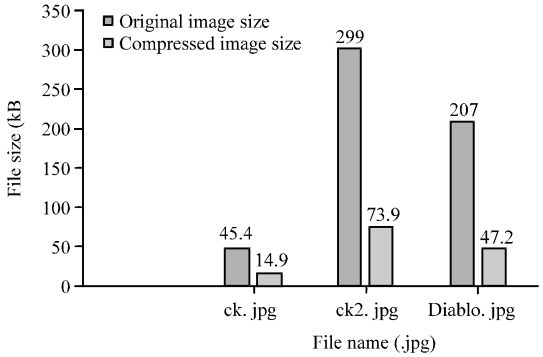

Fig. 6: Graphic from compression using DCT method

compressed image using Huffman method and we can see that the compressed image size is significant reduced and the compression ratio is high enough for the examples are ck2.jpg and Diablo.jpg.

From Table 3, we can make graphic from the differences image size between the original image and the compressed image as we can see in Fig. 5.

From Table 4, we can make graphic from differences image size between the original image and the compressed image as we can see in Fig. 6.

From Table 4 and Fig. 7, we can make a graphic of differences between the original image and the compressed image using Huffman or DCT method in image compression.

From Table 5, we can make a graphic of differences compression ratio between Huffman method and DCT

Table 5: The compression ratio between Huffman and DCT table

File names	Huffman ratio (%)	DCT ratio (%)
ck.jpg	56	67
ck2.jpg	86	75
Diablo.jpg	87	77

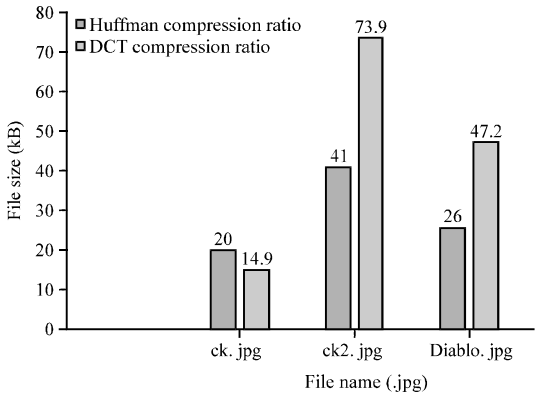

Fig. 7: Graphic comparation between Huffman and DCT methods

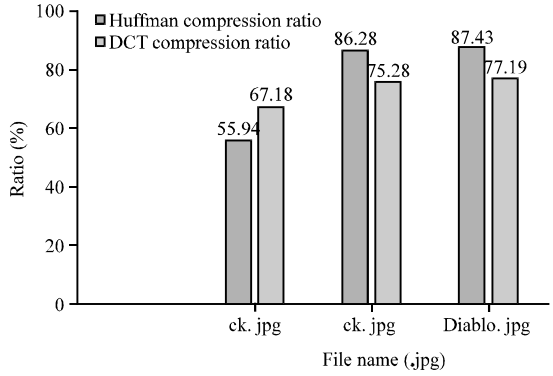

Fig. 8: Graphic compression ratio comparation between Huffman and DCT methods

method on image compression methods as we can see in Fig. 8. From Fig. 8, we can see the compression ratio from Huffman method and DCT method. The Huffman method has higher ratio on ck2.jpg and Diablo.jpg but has lower ratio on ck.jpg.

CONCLUSION

The study from this experiment is as, we can see on the graphic and the table that from Huffman method and DCT method they have many various results on compressed image.

The Huffman method gives us more small size compressed image with high compression ratio but the result from Huffman method is not good as DCT image result.

The DCT method gives us not a significantly reduced size on the compressed image and have compression ration under the Huffman compression ratio but the image result still good enough as the original image.

From this experiment, we can know that the DCT method is the best method to use when we want to compress the image and get the best result if we want to compress the image and get the smallest size for the result, we can use the Huffman method for compressing the image.

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