International Journal of Education and Social Science Research

ISSN 2581-5148

Vol. 4, No. 03; May-June 2021

IMAGE COMPRESSION USING METHOD ON DCT (DISCRETE COSINE TRANSFORM) LOW RESOLUTION CAMERA

Yohanes Pracoyo Widi Prasetyo

Faculty of Engineering
University 17 August 1945 Banyuwangi

DOI: http://dx.doi.org/10.37500/IJESSR.2021.4302

ABSTRACT

Image compression remains a material for analysis in discussions and challenges are always tested for the level of optimization all the time because any image that is visually visible to the human eye needs to be shared and transmitted to others. In this transmission process, you will be faced with speed constraints and the similarity of information contained in the source image. The process of transferring data between digital devices is demanded to have high speed and small file size for reasons of saving storage space. The low resolution camera type is chosen to save the infrastructure cost user and the maintenance cost is quite low, but it is still optimal for use in surveillance camera applications, webcams and area detection cameras that do not require moving image capture.

The DCT (method was Descret Cosine Transform) chosen because it has tested its optimization level in image compression. In the simulation with Mat Lab, it can be seen that the image blocks are separated to be quantified and processed by the encoder by performing a re-construction. This will result in a smaller image file size than the source image file without losing too much information in the image.

KEYWORDS: image compression, DCT, resolution

I. INTRODUCTION

Image retrieval at this time has become an integral part of all human activities, ranging from those that are fun, entertainment to the needs of daily work. From the image capture process, the types of images will be obtained, namely low-resolution images and high-resolution images. Low resolution images are usually produced by cameras with small pixel density quality, while high resolution images are produced by cameras with high pixels. The image data will be used for various purposes, stored or to be sent to other people. If it is to be sent to someone else, it must go through a transmission medium which is called transmission. In the process of sending this data, it will go through the process of sending from the source media which functions to take an image and then send it through the channel and frequency to then be received by the receiving media.

Low resolution cameras will be chosen for reasons of cost efficiency and usefulness. The use of low-resolution cameras is spread in many places and media, namely on portable computers (laptops) or surveillance cameras at homes, offices and public places, so as to produce good images even though not with high resolution. This camera is easy to operate and inexpensive to maintain, but still has an image with a good enough resolution if it is intended to record images with minimal movement, gives an image display of a wide area situation and does not require image detail with a high pixel density level. In the application, the image will be sent to the user to be used as information, so the process of sending the image data must be compressed to get a small size so that the sending process can take place quickly.

In this compression process, the DCT method is known, (Discrete Cosine Transform) which is one of the source coding transformation methods to perform the image compression process. From the simulation results with this method, the results of the reconstructed image after being transformed will get a signal that is close to the source image. and has the advantage of compressed density by producing a smaller size so that the transmission process is faster. [1]

The DCT (method Discrete Cosine Transform) will calculate the quantity of image bits in which the message is hidden. Although the image compressed with this method lossy compression will lead to predictions due to changes in LSB (Least Significant Bit) that look real, in this method, this will not happen because this method occurs in the frequency domain and in the image, not in the spatial domain., so that there will be no visible changes in the external image. While the weakness is that it is susceptible to changes in an object because the signal is easily removed because the location of data insertion and data generation using the DCT method is known. [2]

II. IMAGE COMPRESSION IMAGE

compression is a data compression process performed on digital image data which aims to reduce the redundancy of the data contained in the image so that it can be stored and transmitted efficiently. There are two compression methods, which are lossless which will produce the same image as the source, in this case no information is removed, while the lossy method is a method to produce an image that is almost the same as the source image, in this case there is information lost during the compression process but not change significantly the important information that will be reconstructed. [3]

Image compression is needed because it is generally large in size, so it is impractical in the storage process if it has to be transmitted it will overload the network and the process will not be fast. In addition, data compression is required by eliminating data duplication so that the data sent does not repeat data that is already known.

With a good method, the benefits of this compression will be obtained, namely the process of sending data on the data communication channel is shorter, the need for storage memory space is less than the uncompressed image. [4]

In choosing the right image compression method, it must be able to show a good reconstruction process and results, namely:

1. Fast image compression and decompression process. The process of compressing the image on the source image is encoded with a representation that minimizes memory. Compressed images are stored in a file with a specific format. The decompression process treats the image that has been compressed back into a representation that matches the image before it is compressed and saved in a format that has been reconstructed.
2. Minimum storage space required, the size of the compressed memory depends on the compression method used and the image itself. Images that contain a lot of dual element data will be compressed and produce an image with less memory.
3. The quality of the reconstructed image is good, the information lost due to compression should be as minimal as possible so that the quality of the compressed image is close to the source image being processed. Measuring the quality of the compression results with PSNR (Peak signal-to-noise ratio). To calculate the PSNR, the MSE (calculated mean squared error) issuing the formula: [5]

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N} \qquad (1)$$

So, to calculate the PSNR value the following calculation is used:

$$PSNR = 10\log_{10}(\frac{R^2}{MSE} \qquad (2)$$

Description:

MSE = mean squared error.

PSNR = *peak signal-to-noise ratio.*

M, N, m, n = the block size of the image to be compressed.

R = the maximum fluctuation of the image data input

DCT (Discrete Cosine Transform)

DCT is a technique used to convert the signal into its basic frequency components. The advantages of DCT can be seen even though the image compressed with lossy compression will not cause a lot of information loss because this method compresses the frequency domain in the image, not the spatial domain so that changes that occur in the image are minimized. Meanwhile, one of its weaknesses is that DCT is vulnerable to changes in an object because signal messages are easily deleted because the location of data insertion and data generation using the DCT method is already known. As a compression method that has proven reliability and is widely used in the process of sending data, there are two types of displays, namely 1-dimensional and 2-dimensional images. [6]

A. Discrete Cosine Transform - 1 Dimension

ISSN 2581-5148

Vol. 4, No. 03; May-June 2021

DCT from a series of real numbers d (x), x = 0,…, n-1, is formulated as: The sequence d (x) is obtained again from the d (u) transformation using Inverse Discrete Cosine Transform (IDCT), formulated as follows: [7]

$$d(x)=\sqrt{\frac{2}{n}\sum_{x=0}^{n-1} d(u)C(u)\cos\left(\frac{(2x+1)u\mu}{2n}\right)}$$

Where: U = 0,… n-1 where C (u) = 2-1/2 for u = 0 1 for others. Equation 3 denotes d as a linear combination of the base vector. The coefficient is the transformation element d, which reflects the number of times each frequency is included in the input d.

B. Discrete Cosine Transform - 2 Dimension

DCT-2D is an improvement over DCT-1D, therefore discrete transformations can also be expressed in terms of equations. In the JPEG algorithm, the sample image I (i, j) is divided into 8x8 blocks. Each block is transformed into 8x8 DCT coefficient matrix. The mathematical definition of each coefficient block that is processed will be defined as follows:

The equation used in the DCT transformation for two-dimensional images:

$$F_{(m,n)}=\frac{2}{\sqrt{MN}}c_{(m)}c_{(n)}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\frac{\frac{f_{(x,y)}\cos((2x+1)}{2M}\cos((2y+1)n\pi)}{2N}$$

Where, $c_{(m)}c_{(n)}$ = 1 / √2 for m,n = 0 and $c_{(m)}$, $c_{(n)}$ = 1 for the others. To retrieve the original data from this compressed data, a decompression process using themethod is required *inverse* DCT. In this transformation, a reconstruction process is carried out, namely returning the frequency component to the original signal component. The equation used is:

$$F_{(x,y)}=\frac{2}{\sqrt{MN}}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}c_{(m)}c_{(n)}F_{(m,n)}\cos\frac{(2x+1)m\pi}{2M}\cos\frac{(2y+1)n\pi}{2N}$$

where F (m, n) is the DCT signal from f (x, y), and = 1 / √2 for = 0 and = 1 for the others.

DCT has two characteristics for image and video compression, namely:

1. Concentrating the image energy into a small number of coefficients (*energy compaction*).
2. Minimizing the interdependence between the coefficients carried out *(decorrelation*) The

selection of the constant factor is in such a way that the vector base is orthogonal and normalized. DCT can also be obtained from the vector product (input) and nxn orthogonal matrix, where each row is a vector base. The eight base vectors for n = 8 can be seen in Figure 1. Where each base vector corresponds to a specific frequency sinusoid curve. *Discrete Cosine Transform* represents an image resulting from the sum of the sinusoids of varying magnitudes and frequencies. The characteristic of

DCT is that it changes the significant image information which is emphasized only on a few DCT coefficients. That is why DCT is often used for image compression such as JPEG. The *Discrete Cosine Transform* (DCT) coefficient shows the frequency distribution content in the image. The transformation has a compact nature so that image information can be stored in a small number of transformed coefficients. For efficiency reasons, block size is usually chosen which is a multiple of power 2. DCT is *reversible* so that the coefficient of the DCT transformation that is not processed in the next process can reproduce the reconstructed image according to the original. The reconstructed image can be viewed as a linear combination of the DCT base function, for example the two-dimensional DCT base function for different matrix sizes will produce different base functions shown in Figure 1 DCT tends to be used for compression because it can reduce the occurrence of the same pixel repetition. the adjacent areas [8]

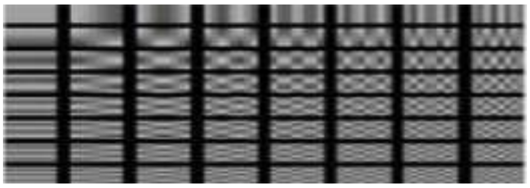

Figure 1. Database 2 Dimensional DCT

characteristicsDCT

DCT has several characteristics, among others: dekorelasi(decorrelation), compaction energy (energy compaction), the separation process of transformation(separability), symmetry (symmetry), and orthogonal (orthogonality). [9]

Dekorelasi(decorrelation)

Nature or karakeristik DCT makes an image or images become terdekorelasi ie the process of eliminating the pixels within walking distance that has an excessive burden that can diinkodekan independently, so that the amplitude of the autocorrelation is very small, in terms of usability dekorelasi this is to get the amplitude of an autocorrelation results in a smaller image into sebagimana shown in Figure 2.

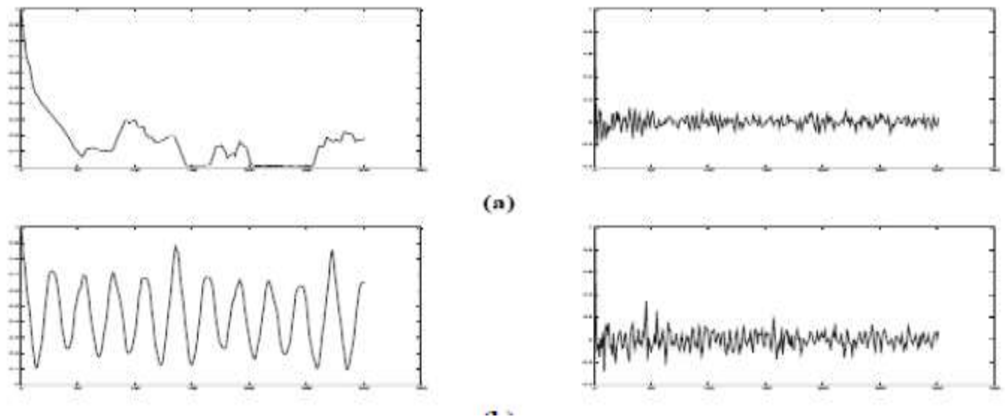

Figure 2 (a) and (b) Normalized autocorrelation before and after DCT [9]

compaction energy (energy compaction)

in the process of this energy compaction, the transformation scheme can be seen from its superiority to package an input data into the least coefficient, which eliminates coefficients with relatively low amplitudes without showing other visual distortions from the reconstructed image. DCT will compress the optimal energy of a particular image or a correlated image, where an irregular image will have a sharper variation intensity level when compared to a regular image, so that this irregular image has a higher frequency content. So it can be concluded that an irregular image has scattered energy while a regular image has regular or packaged energy with a low frequency region.

The Transformation Separation Process (Separation)

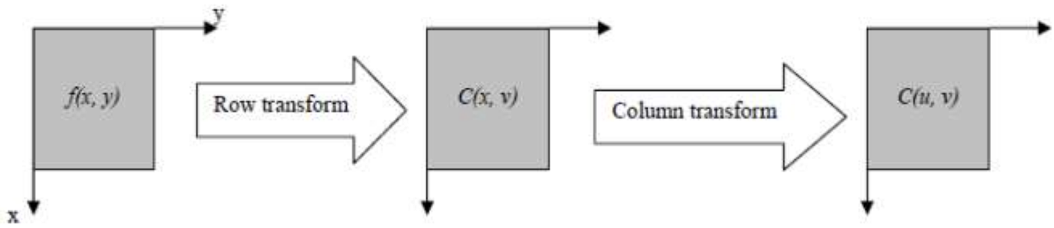

Figure 3. The Transformation Separation Process [9]

In Figure 3 is a transformation separation process where a function f (x, y) will initially be transformed in the row section, namely the function (y) to (v) so that the function changes to C (x, v), after which C (x, v) is transformed back into the column section function (x) becomes (u) so that it will form a function of the new equation, namely C (u, v). [10]

Symmetry (Symmetry)

Another processing of the column and row operation method shows that this operation is functionally the same or identical as a symmetrical transformation below

$$T = AfA \tag{6}$$

Where, A is the symmetric transformation matrix of N x N where, N is a (i, j), namely:

$$a(i,j) = \alpha(j)\sum_{j=0}^{N-1}\cos\left[\frac{\pi(2j+1)i}{2N}\right] \tag{7}$$

And f is the image matrix of N x N.

Orthogonal (*Orthogonality*)

From the symmetrical transformation T = AfA above can be transformed into

$$f = A^{-1}TA^{-1} \tag{8}$$

As the theory of the DCT method, the DCT base function is orthogonal, so the inverse transformation of the matrix A is the same as the transpose function, as follows:

$$A^{-1} = A^{T} \tag{9}$$

Image Resolution

A digital image derived from a digital photo is composed of millions of small dots called pixels (pixels). Pixel itself is a word that comes from the abbreviation Picture Elements. [11] Each pixel has information that determines the color (hue), the strength of the color (saturation) and how bright the color is displayed (brightness). Since almost all photos consist of millions of pixels (1 megapixel = 1 million pixels), then In plain view, it is almost impossible to recognize a separate pixel anymore, what is seen is a complete photo unit with subtle gradations between light and dark, shifting colors and tones. The resolution of a digital image is measured in pixels per inch (ppi - pixels per inch), and the standard resolution for photo quality is 300 ppi. So to find out how many megapixels a digital camera has, measurements print optimal are made for the photos that the camera produces. [12]

A digital camera has a resolution of 0.48 Megapixels (MP) with an exact size of 640 pixels (length) x 480 pixels (width) - bringing the total to 0.48 MP. To calculate the optimum print size that the camera can produce, divide 640 x 480 pixels by 300 ppi and the results are 2.1 inches and 1.6 inches. So, a digital camera with a resolution of 0.48 MP can produce photo prints with a size of 2.1 x 1.6 inches or 6 x 4 cm. For the screen on the monitor, the standard used is 72ppi (Windows) and 96ppi (Mac), so the display on the monitor screen is actually lower than the standard resolution for print (300 ppi). What this means is, a photo that still looks good on the monitor doesn't necessarily have the same level when printed on a printer, but a photo that starts to look like pixelated when printed at 300 ppi allows it to still look good on a computer monitor.

An image file format must be able to incorporate image quality, file size and compatibility with various applications. The standard image file format in use today consists of several types. These formats will be used to save the image in a file. Each format has its own characteristics. These are examples of common formats, namely: Bitmap (.bmp), Tagged Image Format (.tif, .tiff), Portable Network Graphics (.png), JPEG (.jpg), etc. There are even two types of image file formats that are often used in image processing, namely bitmap images and vector images [13]. In a bitmap image, it is also known as a image raster. Bitmap image stores digitally coded image data and is complete with storage using the per pixel method. This bitmap image is presented in the form of a matrix or mapped using binary numbers that include other number systems. This image has the advantage of manipulating color, but it is quite complicated in changing objects. The results of this bitmap display are able to show the smooth gradation of shadows and colors of an image. However, if the display is enlarged, the display on the monitor will appear divided due to a decrease in image quality. The vector image file format is a vector image generated from mathematical calculations and there are no pixels, this means that the data stored is in the form of a position vector, where the data is stored only position vector information only as a function. Changing the color is more complicated in vector images, whereas changing the values will be much easier. [13]

III. DISCUSSION

In this simulation we will use the MatLab program with the results of the camera photo on the webcam with the resulting file specifications as follows:
The matlab function is inverse DCT generated by calling get Inv DCT Transform which is in a separate file.

```
function t = getInvDCTTransform (im, N)
s = dctmtx (N);
t = s' * im * s;
```

whereas for the DCT function the transformation is generated with getDCTTransform

```
function t = getDCTTransform (im, N)
s = dctmtx (N);
t = s * im * s';
```

MatLab toolbox function with dstmtx with data allocation in the form of n shows the transformation process in the form of a matrix.

```
function c = dstmtx (n)
% DSTMTX Discrete sine transform matrix.
% D = DSTMTX (N) returns the N-by-N DST transform matrix. D * A is the DST
```

Returns N with the transformation matrix D * A where column A and D * A are the inverse DST of column A this occurs when A is N by N

ISSN 2581-5148

Vol. 4, No. 03; May-June 2021

```
% website: <a
href = "matlab: web ('http: //www.biomecardio.com ') "> www.BiomeCardio.com </a>

% I / O Spec
% N - input must be double at N
% D - output DCT transform ondual matrix
 iptchecknargin(1,1, nargin , mfilename);
iptcheckinput (n, {'double'}, {'integer' 'scalar'}, mfilename, 'n', 1);
 [cc, rr] = meshgrid (0: n-1);
 c = sqrt (2 / n) * sin (pi * (2 * cc + 1). * (rr + 1) / (2 * n));
c (n, :) = c (n, :) / sqrt (2);
```

The amplitude of the base function is expressed as the coefficient in the set resulting from the DCT transformation. Next the program calls the rory.jpg image file

```
clc;
clear all;
close all;
A = imread ('rory.jpg');
figure, imshow (uint8 (A))
title ('Original Image');
A = double (A);
[s1 s2] = size (A);
bs = 16;
```

The transformation process using the DCT method by generating the DCCtransform function (croppedImage.bs)

```
% DCT
temp = double (zeros (size (A)));
for y = 1: bs: s1-bs + 1
    for x = 1: bs: s2-bs + 1
        cropped Image = A ((y: y + bs-1), (x: x + bs-1));
        t = getDCTTransform (cropped Image, bs);
        temp ((y: y + bs-1), (x: x + bs-1)) = t;
    end
end
figure, imshow (uint8 (temp))
title ('DCT');

% Inverse DCT
```

```
temp1 = double (zeros (size (A)));
for y = 1: bs: s1-bs + 1
   for x = 1: bs: s2-bs + 1
      cropped Image = temp ((y: y + bs-1), (x: x + bs-1));
      t = getInvDCTTransform (cropped Image, bs);
      temp1 ((y: y + bs-1), (x: x + bs-1)) = t;
   end
end
figure, imshow (uint8 (temp1))
title ('Inverse DCT');
```

An inverting transformation that maps the set of DCT transformations to the set of all numbers is also called *inverse* DCT (IDCT). Two-dimensional DCT can be seen as the composition of the DCT in each dimension. For example, if the set of real numbers is given in the form of a two-dimensional array for each row then perform a one-dimensional DCT on each column of the DCT results.

Figure 3. Image source

Image in Figure 3 is the result of camera capture with dimensions of 640 x 480 and a bit depth of 24 measuring 63.8 kb. In Figure 4 an analysis is carried out that there is a grouping of images with fixed fields and objects.

Figure 4. DCT Process

The base image is depicted as a combination of two cosine waves on a vertical axis in a two-dimensional plane with a frequency representing the change in degrees of gray between dark and light. In color image, DCT is performed on each color channel, where each channel can be considered as a image grayscale. If the length or width of the image remains when divided by the length or width of the block, then the padding process must be carried out by adding pixels to the length and width dimensions of the image. After inverse transformation, the padding result is discarded. [14]

From the results of the DCT process in Figure 4, concentrate the image energy into a small number of coefficients (energy compaction), then minimize the interdependence between the coefficients (decorrelation). The coefficient with a small value so that it can be removed without significantly affecting the image quality.

Figure 5results, inverse namely the reconstruction of the source signal coding after going through the transformation process to produce an image that is close to the source image.

Figure 5. Inverse DCT DCT

transformation can be done directly or by dividing into small blocks first. The transformations can then be processed separately for each block. This division has the effect of making processing easier.

IV. COVER

CONCLUSION

In the simulation using DCT to compress the image with low resolution camera then acquired some of the characteristics at the time of the data processing:

1. Image compression no visible difference in the quality of striking despite the significant changes in file size. This is because the compression technique used (DCT) is included in the category of lossy compression 2. From the results of the simulation with Matlab that were carried out on image compression blocks using the DCT method, the output image was obtained based on compression that

had been tested on compression blocks. image, where the results of the compression can be distinguished image quality by comparing the source image from the human visual that is seen directly.

3. The use of low-resolution cameras such as webcams will provide efficiency in the use of surveillance cameras because the price is economical but the results are quite good without significant signal loss at the receiver (encoder) and in terms of compression results can provide a smaller size so as to save data storage space.

BIBLIOGRAPHY

[1] Jumain,Yuliana Melita. 2011.Kompresi Gambar atau citra Menggunakan Discretecosine Transform.Jurnal Teknika, Vol. 3 No 2.

[2] http://anoa5.wordpress.com/2010/05/08/perbedaan-discrete-cosine-transform-dct-dan-discrete-wavelettransform-dwt/ (diakses pada tanggal 11 Desember 2014)

[3] Hermawati, Pengolahan Citra Digital. Yogyakarta: Penerbit ANDI,2013.

[4] Khalil,M.I. 2010. Image CompressionUsing New Entropy Coder.International Journal Of Computer Theory and Engineering, Vol. 2,No. 1.

[5] W.Y. Wang, 2009. “New Lossless Compression Method for JPEG”,Pacific-Asia Conference on Circuits,Communications and System Datasheet SRF04

[6] M. I. Khalil “Image Compression Using New Entropy Coder”,Paper On international Journal of Computer Theory and Engineering,Vol 2, february 2010

[7] Shofiyah, 2010."Studi Perbandingan Kompresi Menggunakan Metode Descrete Cosine Transform (DCT) dan Descrete Wavelet Transform (DWT) pada Citra Digital," Skripsi Teknik Informatika Universitas Islam Negeri Maulana Malik Ibrahim, Malang.

[8] Krikor Lala, Sami Baba, 2009. Thawar Arif.“Image Encryption Using DCT and Stream Cipher”.. European Journal of Scientific Research, ISSN1450-216X Vol.32 No.1 pp.47-57.

[9] Khayam, Syed Ali. 2003. The Discrete Cosine Transform (DCT): Theory And Aplication. Michigan State University: Department of Electrical & Komputer Engineering

[10] Pramitarini, yushintia. 2011. Analisa Pengiriman Citra Terkompresi JPEG Dengan Teknik Spread Spektrum Direct Sequence (DS-SS). Surabaya: Institut Teknologi Sepuluh November

[11] http://www.photocourse.com/itext/pixels/pixels.pdf (diakses pada tanggal 16 Desember 2014 pukul 08.00 WIB)

ISSN 2581-5148

Vol. 4, No. 03; May-June 2021

[12] Rahmanti, Farah Zakiyah. 2010. Pengelompokan Gambar Berdasarkan Warna Dan Bentuk Menggunakan FGKA (FAST GENETIC KMEANS ALGORITHM) Untuk Pencocokan Gambar. Surabaya: Politeknik Elektronika Negeri Surabaya

[13] Iqbal, Muhammad. 2009. Dasar Pengolahan Citra Menggunakan Matlab. Institut Pertanian Bogor.

[14] Setiadikarunia, Daniel, Yohanes Danandy. 2008.Teknik Adaptive Watermarking pada Domain Spasial untuk Penyisipan Label pada Citra Digital Program Studi Teknik Informatika, Institut Teknologi Bandung