UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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IMAGE COMPRESSION USING DISCRETE COSINE TRANSFORM (DCT)

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Industrial Electronic) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Industrial Electronic) with Honours. The member of the supervisory is as follow:

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ABSTRACT

Image compression is a vital process that can be important to current lifestyle. It can be defined as a method that reducing the size of an image so that the users can stored many images in a system without losing the quality of the original image. This project proposes a new image compression that used method discrete cosine transformation (DCT). The effectiveness of this method has been reasonable so that the image can be reduced in size but maintaining the quality. MATLAB software is an important platform for this project in order to write a program and perform the progress of project phase by phase to achieve the expected result.

ABSTRAK

Pemampatan imej adalah satu proses penting yang boleh menjadi penting untuk gaya hidup semasa. Ia boleh ditakrifkan sebagai satu kaedah yang mengurangkan saiz imej supaya pengguna boleh menyimpan imej yang banyak dalam sistem tanpa kehilangan mutu gambar asli. Projek ini mencadangkan pemampatan imej baru yang digunakan kaedah transformasi Kosinus diskret (DCT). Keberkesanan kaedah ini telah sewajarnya supaya imej dapat dikurangkan dalam saiz tetapi mengekalkan kualiti. Perisian MATLAB merupakan platform penting bagi projek ini untuk menulis atur cara dan melaksanakan kemajuan projek fasa dengan fasa untuk mencapai seperti yang dicanangkan.

DEDICATION

I would like to dedicate to my parent, family and all my friends.

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I would like to express my gratitude to everyone who played a role in my project accomplishments.

First, I would thank God for being able to complete this project with success and thanks to my parent, who supported me with love and understanding. Without them, I could never have completed this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

MRI / FMRI	-	Function Magnetic Resonance
DWT	-	Discrete Wavelet Transform
DCT	-	Discrete Cosine Transform
SPIHT	-	Set Partitioning in Hierarchical Trees
JPEG / JPG	-	Joint Photographic Experts Group
BMP	-	Bitmap
GIF	-	Graphic Interchange Format
PNG	-	Portable Network Graphic
SVG	-	Scalable Vector Graphic
TIFF	-	Tag Image File Format
YCbCr	-	Luminance; Chroma: Blue; Chroma: Red
RGB	-	Red, Green and Blue
YUV	-	Luminance and Chrominance component
EZW	-	Embedded Zero-tree Wavelet
LIS	-	List of Insignificant Sets
LIP	-	List of Insignificant Pixels
LSP	-	List of Significant Pixels
CR	-	Compression Ratio
PSNR	-	Peak Signal-Noise to Ratio
MSE	-	Mean Squared Error
MATLAB	-	Matrix Laboratory
GUI	-	Graphical User Interface
GUIDE	-	Graphical User Interface Development Environment

CHAPTER 1

INTRODUCTION

1.0 Introduction

In this 21st century, photo, image and video had become one of the crucial things in daily life. The usage of cell phone, camera to take pictures was widespread throughout all the country and the world. Due to that, image compression is important because it saves space, and storage. The compressed image is smaller, so you can have 100 compressed images on your memory card rather than only 10 uncompressed images on memory card. Image compression reduces the size of a image but maintain the quality of image.

1.1 Background

For first dimensions of computerized progressive system, both Europe and North America begun utilizing 2Mbits and 1.544Mbits as target bit rates separately. The resultant picture quality encountered an extremely poor transient quality in fact that it had a decent fleeting goal. From this, it was comprehended that by utilizing short coding for each pixel, the picture quality can be increased. It turned into a plausibility by gathering the pixels in such a way, to the point that the bit per pixel is just fragmentary. Among the 15 square based videoconferencing recommendations submitted to the ITU-T, 14 depended on the Discrete Cosine Transform (DCT) and the staying one depended on

Vector Quantization (VQ). The Joint Photographic Experts Group (JPEG) likewise indicated sharp enthusiasm for packing static pictures. Thinking about dynamic picture transmission, the JPEG aggregate picked the DCT as the primary unit of compression. The ITU-T was impacted by the JPEG's choice of favouring DCT over VQ. At present, it has turn into a pattern to utilize DCT in chips and DSPs.

On the other hand, a DCT may be utilized rather than DPCM, then pursued with MPEG-1. To be more exact, the nature of picture for video conferencing applications was sensible at 384 kbit/s or higher and for 1 Mbit/s and higher bitrates, the picture delivered was of a decent quality. A similar idea was later connected to frameworks dependent on products of 64 kbit/s. The standard definition ended up known as H.261 standard and the coding strategy is alluded as px64 technique (p is a number somewhere in the range of 1 and 30).

1.2 Problem Statement

As our utilization and dependence on PCs and phones keep on developing, so too did our requirement for efficient methods for storing a lot of information. For instance, somebody that utilizes many pictures will need to utilize image compression to store those pictures. There are several problems that occur:

1. The size of original images was too large cause the images were unable to store because of the insufficient space of storage.
2. The higher loss of image detail causes the image quality became poor after compression process such as blurry image.
3. The result of the compressed image ineffective by using other compression method.

1.3 Objectives

The main purposes of this project are:

1. To decrease the size of an image by using Discrete Cosine Transformation (DCT) method.
2. To sustain the quality of an image before and after the compression process.
3. To analyse the effectiveness of the result based on the proposed method.

1.4 Scope

This image compression technique focuses on reducing the size of the images taken by using camera. The community of people that store a lot of data, pictures and videos in their computer and phone can use less usage of storage memory. Other than that, it focuses on controlling the quality of images after the compression process. The medical images in hospitals such as CT scan and MRI can use this technique for keeping good quality of these images. The Graphical User Interface (GUI) is used by developed on MATLAB to display the output size of the images after the compression process. It is focuses in multimedia application whereby the digital watermarking is used for copyright. The uses of images in military, geosciences, agriculture and astronomy cause high demand of the remote sensing images that have been produce by using image compression.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

All through this, the literature reviews will be displayed and talked about. This part will cover about the study and thought dependent on the previous just as the idea to achieve this project.

2.1 Past Related Project Research

2.1.1 JPEG Image Compression Using Discrete Cosine Transform

The most well-known system for image compression was Discrete Cosine Transform (DCT). According to Keerti Mishra, R.L. Verma, Sanawer Alam and Harsh Vikram (2013) state that DCT transforms spatial domain into frequency domain, and frequency domain includes low and high frequencies. The DCT is utilized in change for information but has a symmetrical change, which has a settled arrangement of premise function. DCT has numerous favourable circumstances which somehow it can pack vitality in the lower frequencies for picture information and can lessen the blocking antiquity impact that results from the limits between sub-pictures toward becoming visible.

The most well-known mode utilizes the discrete cosine transform is the JPEG pattern coding framework.

JPEG usually easier to code by using the DCT method. According to A.M. Raid, W.M.Khedr, M. A. El-dosuky and Wesam Ahmed (2014) state that JPEG compression reduces file size with minimum image degradation by eliminating the least important information JPEG compression is performed in consecutive steps.

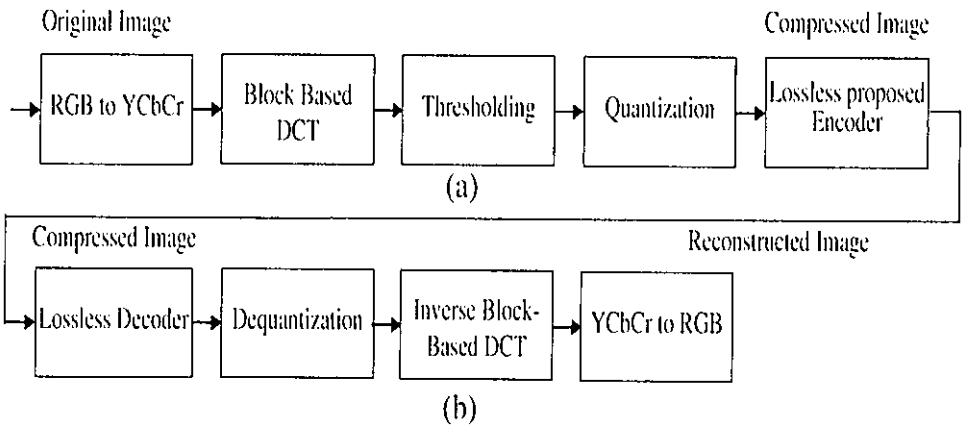


Figure 2.1. Represents the encoder and decoder block diagrams for colour images.

The first step is the conversion of RGB to YCbCr colour. Then, the original image is divided into blocks of 8 x 8. Afterward, the pixel in each square is moved from [0-255] to [-128 to 127]. The DCT works from left to right, through and through accordingly it is connected to each square. Each square is packed through quantization. At that point, quantized lattice is entropy encoded. The compacted picture is reproduced through invert process. This procedure utilizes the converse Discrete Cosine Transform.

The shading coordinate transformation, the subsequent stage is to separate the three shading parts of the picture into numerous 8×8 squares. For 8-bit picture, in the first square every component falls in the range of [0,255]. Information in that square is revolved around zero and will be delivered in the wake of subtracting the mid-purpose of the range of 128 from every component in the first square, with the goal that the changed range is moved from [0,255] to [-128,127].

Pictures are isolated into parts of various frequencies by the DCT. The quantization step disposes of less vital frequencies and the decompression step utilizes the critical frequencies to recover the picture.

This equation gives the forward 2D-DCT transformation:

$$F(u,v) = \frac{2}{N} C(u)C(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

for $u = 0,\ldots,N-1$ and $v = 0,\ldots,N-1$

$$\text{where } N = 8 \text{ and } C(k) = \begin{cases} 1/\sqrt{2} & \text{for } k = 0 \\ 1 & \text{otherwise} \end{cases}$$

This equation gives the inverse 2D-DCT transformation:

$$f(x,y) = \frac{2}{N} \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} C(u)C(v)F(u,v) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

for $x = 0,\ldots,N-1$ and $y = 0,\ldots,N-1$ where $N = 8$

After dct transformation, the "DC coefficient" is the component in the upper most left comparing to (0,0) and the rest coefficients are classified as AC coefficients. (A.M. Raid, W.M. Khedr, M. A. El-dosuky and Wesam Ahmed, 2014)

2.1.2 A Digital Image Watermarking Algorithm Based on DCT

According to Kitty Arora (2014) state that DCTs are used to convert data into the summation of series of cosine waves oscillating at different frequencies. The Discrete Cosine Transform is an exceptionally work change that changes a flag from spatial area to recurrence space and it has been utilized in JPEG standard for picture compression because of a good execution. As that change occur, DCT changes the information into range and in this way, it will keep away from the

issue of excess information. The outstanding square based DCT change sections into an image of non-covering square and applies DCT to each square. This realize giving three repeat sub-gatherings: low repeat sub band, mid-repeat sub-band and high repeat sub-band. DCT-developed watermarking is arranged thinking about two key realities. The first is that the greater part of the banner essentialness lies at low-frequencies sub band which contains the most indispensable pieces of the image and second one is that high repeat sections of the image are ordinarily ousted through pressure and racket.

There are four built up sorts of DCT, DCT-I, DCT-II, DCT-III, and DCT-IV. The DCT-II is generally connected in flag handling since it is asymptotically equal to the Karhunen–Loeve Transform (KLT) for Markov-1 signals with a relationship coefficient that is near one. For instance, JPEG picture compression is additionally founded on the DCT-II. The two-dimensional DCT is generally utilized in computerized picture handling. Given a picture size of N×N, the DCT of the picture is characterized as:

$$C(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\times$$

$$\cos\left[\frac{\Pi(2x+1)u}{2M}\right]\cos\left[\frac{\Pi(2y+1)v}{2N}\right]$$

And the inverse transform is defined as

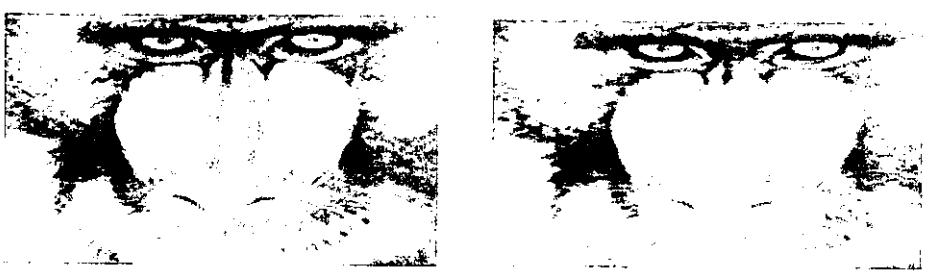
$$f(x,y) = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} \alpha(u)\alpha(v)C(u,v)\times$$

$$\cos\left[\frac{\Pi(2x+1)u}{2M}\right]\cos\left[\frac{\Pi(2y+1)v}{2N}\right]$$

In watermark embedding, one-level Haar DWT is apply to decay the host picture A, into four sub-groups that are ALL, AHL, ALH, and AHH. Then, consider AHL is isolated into 8×8 square squares. 2D DCT is perform to each square, the DC estimation is gather for each DCT coefficient grid D1(x, y) together to get another network M1. Now consider ALH and discover the Coefficient framework D2(x, y) and another new lattice M2, same as stage 2. SVD is apply to M1 and M2, M1=U1S1V1T and M2=U2S2V2T will be acquired. B that contain of two sections, B1 and B2, of size 64×64 each will speak to the watermark picture. The particular qualities S1 and S2 with B1 and B2 will modified separately and apply SVD to them. For the coefficient framework D1(x, y) in stage 2 and D2(x, y) in stage 3, every DC incentive is change to M1*(x, y) and M2*(x, y), then ineverse DCT is apply to each D1*(x, y) and D2*(x, y) to deliver the watermarked center recurrence band AHL* and ALH*. The watermarked picture, AW is acquired by playing out the backwards DWT utilizing two arrangements of changed DWT coefficient (AHL* and ALH*) and two arrangements of non-altered DWT coefficient.

a) Original b) Watermarked

Figure 2.2a Grayscale image "Lena".

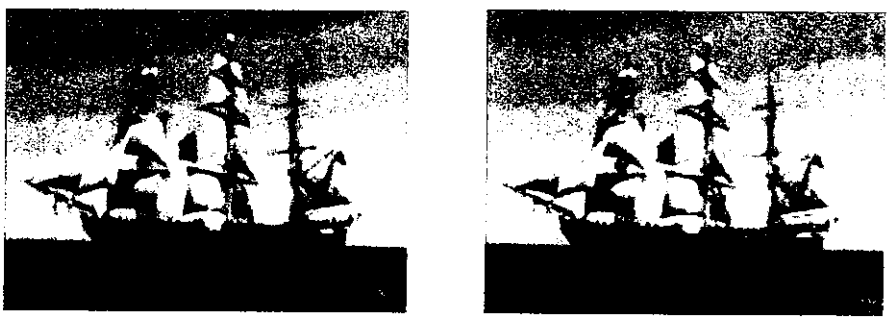


a) Original b) Watermarked

Figure 2.2b Grayscale image of Baboon.

a) Original b) Watermarked

Figure 2.2c Image of "Opera House".



a) Original b) Watermarked

Figure 2.2d Grayscale image of boat.

This watermarking technique depend on DCT technique. In this way, the proposed make method easier. (Md Saiful Islam and Ui Pil Chong, 2014)

2.1.3 A Deep Learning Architecture for Image Representation, Visual Interpretability and Automated Basal-Cell Carcinoma Cancer Detection

According to Prabhjot kour (2015) states that a discrete cosine transform (DCT) express a sequence of many data points in terms of a sum of cosine functions at different frequencies. The fundamental focal point of the image evaluation was to think about the picture portrayals gained from the information, produced by the DL-based proposed strategy, against two standard authoritative