Research Article

QP "DCT and Wavelet transfer (HAAR, DB)" quantization implementation in the frequency domain

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Abstract: This paper compares between three image compression Discrete Cosine Transform (DCT) and Wavelet Transform (Haar, DB), and combines the two of them. The new block incorporates the DCT benefits in which it functions flawlessly with highly correlated data. In addition to, the benefits of the transformation of Haar that provide preferable ends for images exhibiting rapid gradient variations. DCT has been implemented to the upper left corner of the block. Haar has been applied to the remaining parts of the block. The whole process introduces an error in the signal which increases as we raise the value of QP. Finally, is the inverse transform which takes the quantized/de-quantized coefficients and reconstruct the values in the pixel domain. This was done by using proper MATLAB function

Keywords: Wavelets, DCT, frequency domain, HAAR 1 Introduction

Introduction

Nowadays, files are compressed in order to produce image data with a new code, in a compact form. This procedure minimizes the number of bits in representation. However, the use of lossy compression may result in a distorted image. A large amount of data in raster images is why using refutable image compression is important [1]. Every block obtained has been subjected to hybrid transform. their used the methodology exceeds the current DCT and Haar outlines, maintaining a better image quality even when subjected to high ratios of compression. In addition to, providing more PSNR than DCT for the alike amount of compression ratio, and allowing a higher quality edge restoration than the Haar transform [2]. For the Two-Dimensional DCT, its purpose is to examine the efficacy of DCT on images, which requires the expansion of ideas highlighted in the most recent section on two-dimensional space [3]. The model contains two major block processing components with two more sub-block processing components with them. The first component has a 2D–DCT function along with vector quantization function as sub-blocks. The input image file is grouped into 8 9 8 macro blocks before the application of 2D–DCT transform function [4]. DWT has been implemented to analyze images into bands in order to achieve image inaccuracies easily. Because of the appropriate the band selection, it provides a higher value, while in DFT there is an effective distribution of energy, in which protects the image from various attacks, such as rotation, links and sizes. Independent DCT mechanism provides high error and low PSNR [5]. The efficiency of the algorithm proposed is compared to the RLE and DCT state-of-the-art algorithms. The results showed that as opposed to DCT and RLE, the optimized HWT has high PSNR and more CR. [6]. The signal is mapped to the transform domain, using the chosen transform. Here we used DCT and Wavelet (Haar and DB). After this step is done, we will have the transform coefficients ready for quantization. For quantization of each coefficient, it is divided by a Quantization Parameter (QP) which can vary for producing different levels of quality. After the division, the value is rounded and then multiplied by QP again for de-quantization. The whole process introduces an error in the signal which increases as we raise the value of QP. Finally, reproducing pixels in the image are replaced by a new image to be reproduced.

1. DCT

When a signal has been converted into basic frequency particles and based on the division of images into smaller particles that differ in frequencies, this process is often referred to as the Discrete Cosine Transform or DCT. One of the useful features of DCT is the de-correlation, which is the elimination of repeated neighboring pixels [3]. When DCT has been implemented, the automatic correlation shrinks in value. The data becomes uncorrelated. The irrelevant coactives (minor values) can be removed and change the coactives neatly to encode them separately and specifically without duplicating identical data represented in correlated pixels numerous times [7].

Equation 1. expressions an example of the equation of DCT

$$g'(x,u) = \lambda(u)\cos\frac{\pi(2x+1)u}{2N} \tag{1}$$

$$where\ \lambda(u) = \begin{cases} \sqrt{\frac{2}{N}}, & u = 0 \\ \sqrt{\frac{1}{N}}, & otherwise \end{cases}$$

DCT basis is shown in Figure 1.

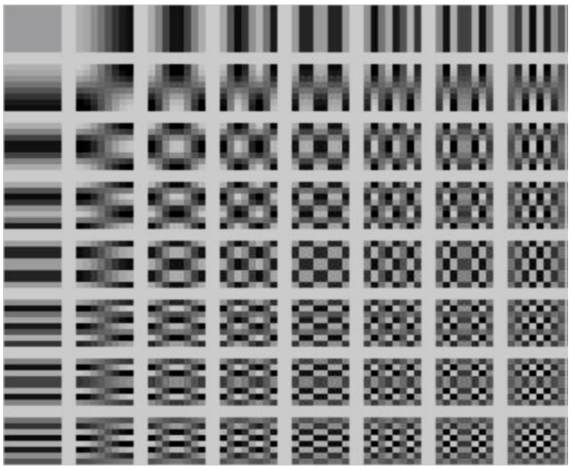


Figure 1. The DCT Basis

2. Wavelet Transform

A technique that is commonly used in order to compress images is Discrete Wavelet Transform. The main aim of Wavelet transform is transforming data from time-space domain into time-frequency domain in order in which it has far more superior data compression. Furthermore, The Isolated Wavelet Transform can have higher compression rate.[2]

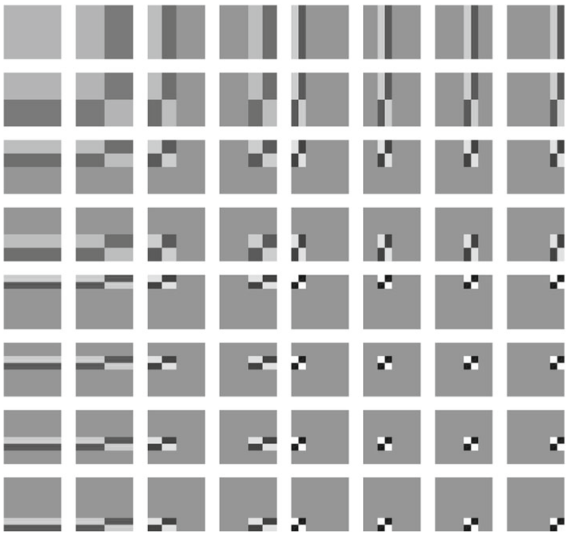


Figure 3. The Haar Basis

2.1. Haar wavelet transform

One of image compression achieve to the improved quality of compressed image is reached by introducing Haar-wavelet based approach. [8]

Equation 2 appearances an example of the equation of the Haar wavelet transform

$$\Psi(x) = \begin{cases} 1, 0.0 \leq & x & < 0:5 \\ -1, 0.5 \leq & x & < 1:0 \\ 0, & otherwise & \end{cases} \quad \phi pq(x) = 2^{p/2}\, \Psi(2^{p}\, x - q + 1)$$ [2] ……….. (2)

2.2. DB wavelet transform

DB wavelet is one of image compression to find domain block in QP quantization of each coefficient, it is divided by a Quantization Parameter (QP) which can vary for producing different levels of quality. After the division, the value is rounded and then multiplied by QP again for de-quantization. The whole process introduces an error in the signal which increases as we raise the value of QP.

3. Process

In this code, first the input image is stored in a variable using MATLAB functions. Then it is transformed from RGB color space to the YCbCr space. This is because most processes are usually done in the Y-plane. However, this code is able to perform the quantization process on any of the planes.

After the color space mapping, the image dimension are compared to the transform size (e.g. 8x8) to check if the original image can be divided to integer number of blocks or not. In case that it is not possible to have integer number of blocks, the code crops proper number of rows and/or columns from its end. After this part, all the preprocess steps are done and we can perform the quantization.

There are two main loops in the code which are responsible to process each square block of the image. For each block and in order to transform/quantize it, the following steps are perfumed:

First, the signal is mapped to the transform domain, using the chosen transform. Here we used DCT and Wavelet (Haar and DB). After this step is done, we will have the transform coefficients ready for quantization.

For quantization of each coefficient, it is divided by a Quantization Parameter (QP) which can vary for producing different levels of quality. After the division, the value is rounded and then multiplied by QP again for de-quantization. The whole process introduces an error in the signal which increases as we raise the value of QP.

The final step is the inverse transform which takes the quantized/de-quantized coefficients and reconstruct the values in the pixel domain. This was done by using proper MATLAB functions.

Finally, reproducing pixels in the image are replaced by a new image to be reproduced.

4. Parameters:

Function code is configurable with a number of parameters:

1. Block size: to the default of 8 is placed.
2. Destripute every image in the four block part 4*4
3. Convert: two into the frequency domain is used: 1) DCT and 2) wavelet (Haar and DB)

Quantization level: To compare the effects of quantization on the output image quality, 10 different levels for variable QP is intended (to convert the DCT values of 3, 6, 9, ..., 30, and for wavelet transform, the values 1, 2,. .. 10 is intended).

5. Analyzing the results:

The progression contains of the following steps:

- The division of the image into 8 × 8 blocks
- Calculating the DCT and Haar transforms for every block based on Eq. 3.

$$\propto = (\text{curBlock} * \mu)' \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where

- curBlock is the 8 × 8 original block,
- μ is the blook 8 × 8 (DCT + Haar) basis (CA +CH).
- ∝ is the blook 8 × 8 (DCT + Haar).

M matrix image block 8*8

Table1. M matrix image block 8*8

99.0000	77.0000	77.0000	88.0000	16.5000	93.5000	154.0000	44.0000
110.0000	22.0000	44.0000	121.0000	104.5000	93.5000	77.0000	77.0000
77.0000	33.0000	16.5000	38.5000	27.5000	16.5000	11.0000	110.0000
143	55.0000	71.5000	49.5000	71.5000	170.5000	132.0000	143.0000
143.0000	55.0000	60.5000	82.5000	154	253	203.5000	126.5000
44.0000	66.0000	137.5000	71.5000	88	143	159.5000	16.5000
27.5000	115.5000	132	110	49.5000	71.5000	115.5000	71.5000
104.5000	104.5000	44	132	148.5000	82.5000	126.5000	16.5000

The table 2 explain numerical value of PSNR criteria for different levels show a QP for wavelet transform and DCT .

Table 2. numerical value of PSNR criteria for different levels show a QP for wavelet transform and DCT**.**

QP	DCT	Wavelet-DB	Wavelet-Haar	Block Size
QP2	PSNR48.0993	PSNR52.4206	PSNR50.9538	8
QP3	PSNR45.4361	PSNR50.0178	PSNR50.4141	8
QP4	PSNR42.5446	PSNR47.0149	PSNR48.689	8
QP5	PSNR41.1893	PSNR45.5917	PSNR44.872	8
QP6	PSNR39.871	PSNR43.7943	PSNR43.3995	8
QP7	PSNR39.528	PSNR42.9065	PSNR41.6067	8
QP8	PSNR38.9028	PSNR41.7999	PSNR40.3052	8
QP9	PSNR38.5182	PSNR41.267	PSNR39.7182	8
QP10	PSNR37.7921	PSNR40.5006	PSNR38.9702	8
QP11	PSNR36.9112	PSNR39.976	PSNR38.3572	8

The following three charts, the numerical value of PSNR criteria for different levels show a QP. As can be seen, with increasing QP, the image quality deteriorates considerably.

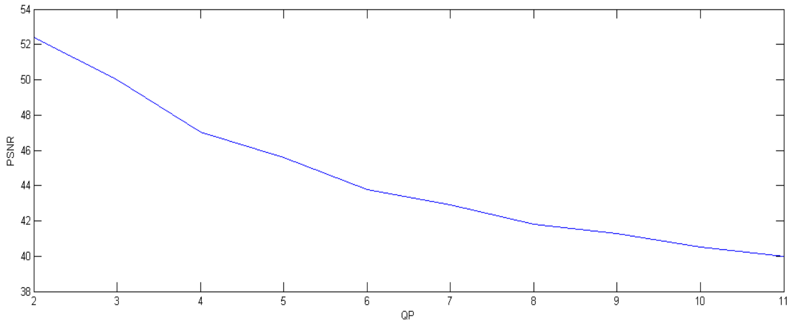


Chart quality "the QP for wavelet transform Haar”

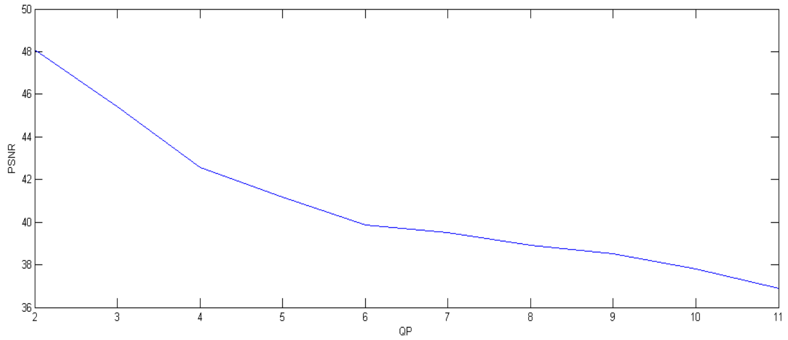


Chart quality “the QP for transforming DCT”

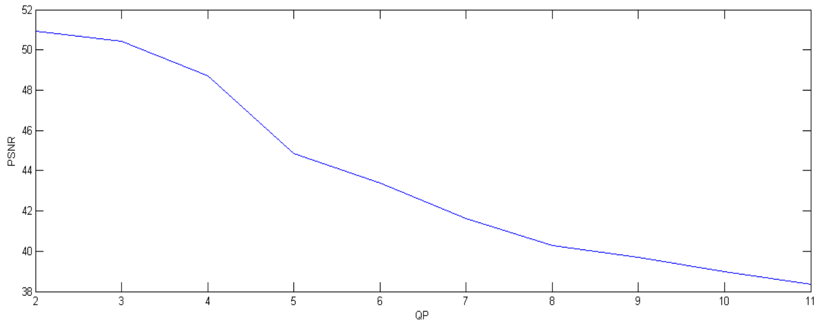
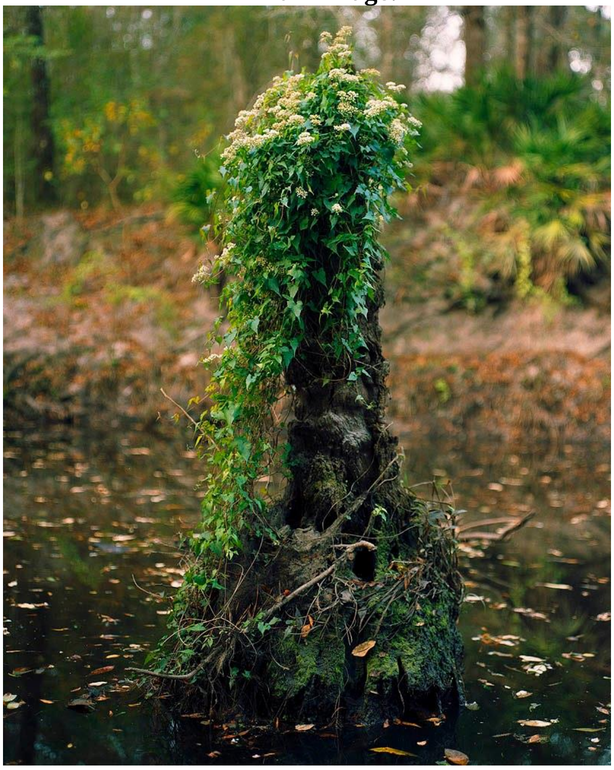


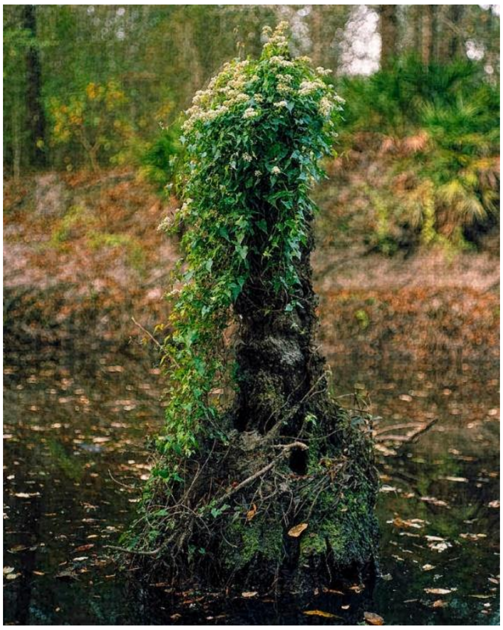
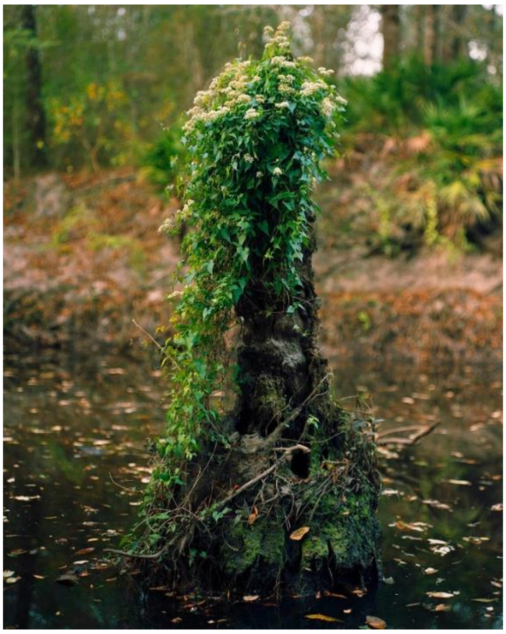
Chart quality "the QP for wavelet transform DB”

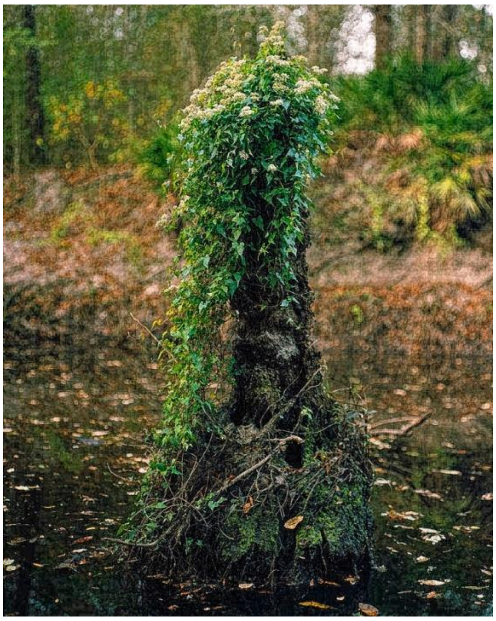
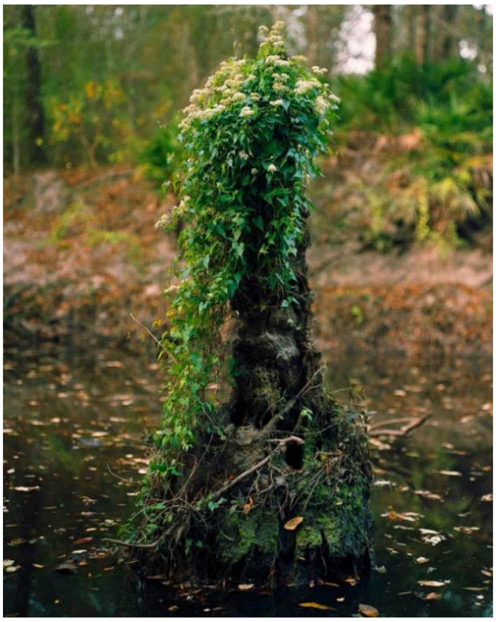
To better understand the differences between different levels of quality in QP, here are a few examples of the different conversion distorted image in the field are:

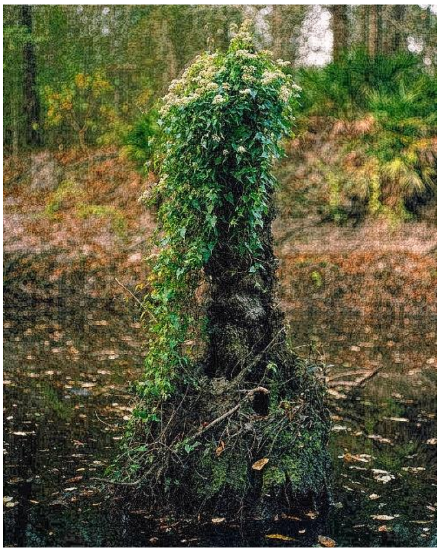
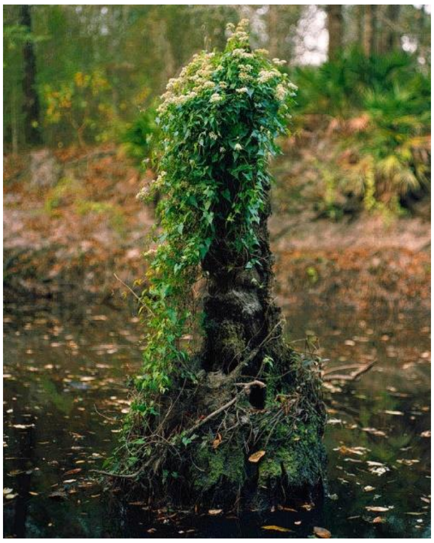
Main image:



High quality image (DCT):

low quality*)* QP30*(*	High Quality*)* QP3*(*	
		DCT
low quality*)* QP30*(*	High Quality*)* QP3*(*	

		Wavelet DB1

low quality (QP30)	High Quality (QP3)	
		Wavelet Haar

Implementation and description Code (all files related to the implementation of MATLAB environment to be placed in the appropriate folder)

6. Conclusion

This study explains DCT and wavelet transforms (Haar, DB) block. It has discussed the benefits of both transformations, though reducing the deficiencies of every one of them. While DCT is practical to the upper left corner of the block the outstanding portions of the block are transformed via Haar. the resulting the equations of the matrix M required to recover the final step is the inverse transform, which takes the quantized/de-quantized coefficients and reconstruct the values in the pixel domain. This was done by using proper MATLAB functions. Finally, reproducing pixels in the image are replaced by a new image to be reproduced.

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