Analysis of Digital Image Stegnography based on Discrete Cosine Transform

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Abstract. The usage of data over the internet has increased exponentially, and data security is an essential topic to consider. The practice of disguising information by embedding pictures onto other images is known as digital image steganography. It's used to keep sensitive information safe from hackers. This study shows how to build digital image steganography using the Discrete cosine transform, which works in the frequency domain rather than the spatial domain, and how it may be utilized in a variety of situations, such as watermarking, as well as what its benefits and drawbacks are.

Keywords: DCT- Discrete Cosine Transform.

1 Introduction

Since ancient time one of the most important topic has been data security. Cryptography can be helpful for securing data as it changes information into cipher text which is hard to reverse, but enough time given every thing can be broken into. On the other hand Steganography is technique which hides data into other data, thus hiding the existence of a information. The word steganography comes from the Greek words steganos (meaning- concealed or covered) and graphos (meaning- writing) (meaning to write).[**under**, 1–3]

2 Background

The human eye can only perceive energy waves whose wavelengths lie in a very narrow band. Visible light is a relatively small part of the broader electromagnetic spectrum, the visible part of which includes light with wavelengths between about 400 and 700 nanometers. Light with a wavelength of 650 nm appears red, light with a wavelength of 550 nm appears green, and light with a wavelength of approximately 475 nm appears blue. Cones are a type of light-sensitive cell in the retina, which gives us our color vision. The three types of cones react differently to different wavelengths of light, so one is sensitive to red, another to green, and another to blue light. blue. These three types of cones are called L, M, and S because they respond to long, medium, and short wavelengths of light, respectively. The L-type cones have maximum sensitivity at wavelengths near 564–580 nm (red) while the M-type peaks at 534–545 nm (green) and the S-type peaks at 420–440 nm (blue). Thus, color perception is gained by combining the sensory information of the three types of cones. About 65% of all cones are of type L while 30% are M and 5% are S. [4]

A color model is an abstract mathematical system for representing colors. Since color is a three-dimensional entity, a color model defines three primary colors from which all possible colors are derived by mixing various amounts of these primary colors. Color models are typically limited in the range of colors they can produce and hence represent only a portion of the visible spectrum.

Color models can be classified as either additive or subtractive. Additive color models assume that light is used to generate colors for display[5]. In an additive color model, the color black represents a complete lack of the primary colors while the color white corresponds to maximum and equal amounts of each of the primary colors. In additive color models all the primary colors are summed to produce a single color. To human black is caused by complete lack of light while white is perceived when large amounts of red, green, and blue are present so humans have additive system . All displays are light-emitting devices that are usually modeled using an additive color model.[**co**]

The RGB color model is the most common way to represent colors in image processing systems. The RGB model is additive and uses red, green, and blue as primary colors, so any color can be achieved by combining different amounts of these three primary colors.[6] Color in the RGB color space is defined by three numeric values that specify the amount of red, green, and blue that includes the specified color. Colors specified using the RGB model are said to be in the RGB color space. For example, for a particular shade of beige, the RGB value is rgb Since RGB is an additive color model, the most common use of this model is to display images on a computer monitor or any display. Computer screens are made up of tightly packed red, green, or blue lights of varying intensity levels. Three of these points form a single color point when viewed from a reasonable distance, and therefore using an additive RGB model is a natural choice for color representation in such a system. . In addition, since most digital images are designed to be displayed on a screen, the RGB model is often used during image processing.

3 Related Work

In this internet era, steganogrphy is closely used in watermarking and fingerprinting. The fundamental purpose of watermarking and fingerprinting is to safeguard intellectual property[7, 8]. All instances of an object are watermarked with a signature to show ownership of the material, which is helpful for copyright protection. In fingerprinting each instance of an object is encoded with a unique signature , allowing the material's owner to identify who is illegally giving it to others. The fact that information is hidden inside files may be public knowledge – sometimes even apparent – in watermarking and fingerprinting, whereas in steganography, the information's imperceptibility is critical.[9] On watermarked or fingerprinted material, one assault would be to remove the signature, which is far more difficult and has a high risk of damaging the document.[10–14]

4 Performance parameter

4.1 MSE

MSE is the average of the squares of errors i.e. average squared difference between the estimated values and the estimate. MSE is always positive and the closer the values are to zero, the better the technique. MSE is calculated between the pixel intensities of cover image and stego image.[15] .

$$MSE = \frac{1}{m \times n} \sum_{i=0}^{m} \sum_{j=0}^{n} (p_{ij} - q_{ij})^2 \tag{1}$$

where,
m×n denotes image dimension
p_{ij} denotes cover image pixel intensity
q_{ij} denotes stego image pixel intensity

4.2 PSNR

The PSNR is a measure of distortion in the result-image.[16, 17] .

$$PSNR = 10log_{10} \frac{MAX^2}{MSE} \tag{2}$$

1. higher PSNR value means lesser distortion.
2. a PSNR value >40 decibels (dB) is considered good. If it is in 30 dB <PSNR <40 dB, is acceptable,
3. PSNR <30 dB is not acceptable because the distortion produced is very high

5 DCT

A discrete cosine transform (DCT), first proposed by Nasir Ahmed in 1972, expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies.[18, 19]

Fowrward DCT transform

$$\begin{aligned} F(m,n) = \; & C(m)C(n) \\ & \times \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} f(i,j) \\ & \times \cos \frac{(2i+1)m\pi}{2N} \cos \frac{(2j+1)n\pi}{2N} \end{aligned} \tag{3}$$

where if $m = n = 0, C(m) = C(n) = \sqrt{\frac{1}{N}}$;
otherwise, $C(m) = C(n) = \sqrt{\frac{2}{N}}$

Inverse DCT transform

$$f(i,j) = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} \times C(m)C(n) \times F(m,n) \times \cos\frac{(2i+1)m\pi}{2N}\cos\frac{(2j+1)n\pi}{2N} \quad (4)$$

6 How DCT work

Taking a host 8x8 pixel image and performing DCT and recovering it. Now, perception of both the images is same to human eyes.

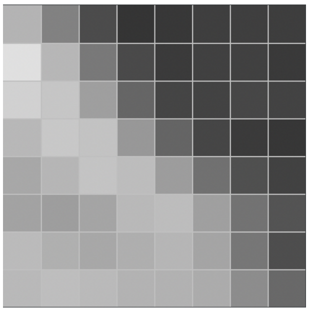

Figure 1: host dct image

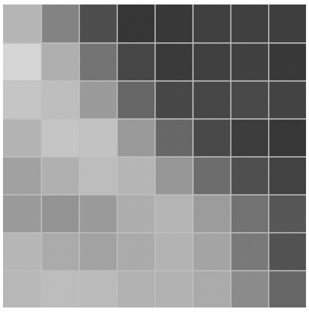

Figure 2: recovered dct image

219	241	234	221	212	209	222	221
189	220	228	229	220	206	216	224
148	183	207	227	227	210	212	222
126	147	170	203	223	221	216	218
129	132	142	169	206	223	220	218
136	138	140	143	178	208	210	214
136	138	144	132	152	179	182	196
135	131	140	128	139	155	150	172

Table 1: host image 8x8 pixel grid

7 processs

A $N \times N$ pixel grid is taken from steo image which is then goes through DCT transformation, then using a quantization table it is quantized (every value in pixel grid is divided by corresponding value of quantization table). Quantized table contains mostly zeros which is suitable. Later on this quantized table is then added onto $N \times N$ grid of cover images and the result is watermarked image.

1485	-148	-21	-12	-7	-16	2	1
207	56	-38	-34	1	2	-21	-1
-6	96	44	-22	-10	0	4	1
21	-10	35	24	-12	0	0	1
-12	-1	-4	12	4	2	0	0
1	-1	0	-2	-3	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Table 2: transformed DCT image

226	229	229	224	215	212	214	219
196	205	216	221	219	216	215	216
157	173	195	212	220	220	217	215
131	147	172	195	211	219	220	219
125	135	152	174	194	208	216	219
131	133	140	154	173	190	201	206
137	134	133	141	155	170	179	183
140	134	130	135	146	157	163	164

Table 3: InverseDCT image

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

Table 4: Quantization Table

As an example the table:5 Quantized DCT image (8x8 pixel grid) which is obtained by from **??**, which is then added to the pixel of cover image, as it has around 83% of pixel are 0 so the resulting pixel grid have changes in only 17% pixels, the obtained result is watermarked image. We repeat this process until all pixels are covered.

this is text cover image and the result image are percieved as same to the eyes.

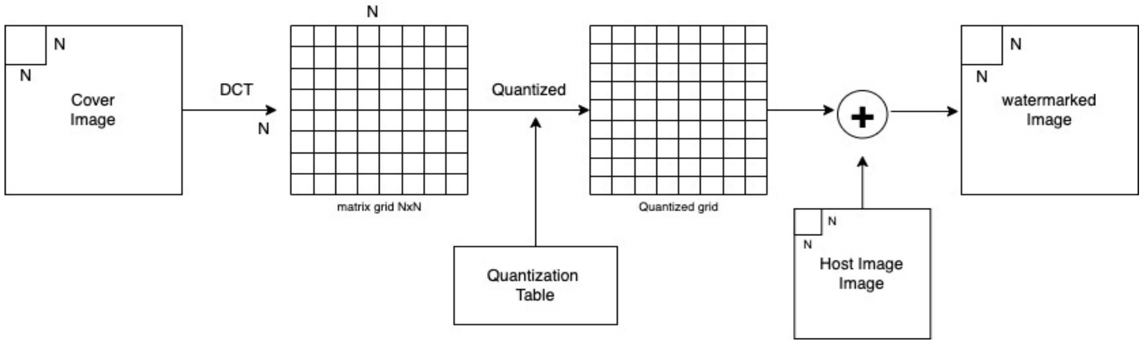

Figure 3: process

92	-13	-2	0	0	0	0	0
17	4	-2	-1	0	0	0	0
0	7	2	0	0	0	0	0
1	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Table 5: Quantized DCT image

Figure 4: cover image

1472	-143	-20	0	0	0	0	0
204	48	-28	-19	0	0	0	0
0	91	32	0	0	0	0	0
14	0	22	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Table 6: DeQuantized DCT image

Figure 5: result image

28	38	59	34	59	85	106	129
46	69	90	69	88	112	133	153
28	77	102	86	106	128	148	166
34	93	92	73	106	139	155	162
13	0	77	98	121	146	158	163
79	75	117	119	135	150	158	168
105	147	143	130	148	159	167	182
136	182	162	144	167	182	192	207

Table 7: cover image

120	25	57	34	59	85	106	129
63	73	88	68	88	112	133	153
28	70	100	86	106	128	148	166
35	93	93	73	106	139	155	162
13	0	77	98	121	146	158	163
79	75	117	119	135	150	158	168
105	147	143	130	148	159	167	182
136	182	162	144	167	182	192	207

Table 8: result image

8 Result

Here, images 6 is used as cover image and 7 is embedded onto it, as a result 8 is produced which following paremeters

PSNR =30.014

MSE =64.82

As PSNR is not less than 30 it is a acceptable scenario.

Figure 6: cover image

Figure 7: steo image

Figure 8: watermarked image

format	performance
png	high
gif	high
jpg	low
Raw	high

Table 9: steganography impact

9 conclusion

In this paper, we talked about steganography and how it is implemented using Discrete Cosine Transform in frequency domain of images. This have its requirement data hiding, watermarking - which can be used for application such as copyright ownership, protecting content on ott platform, possesion of stock images and other various fielf with robustness

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