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MODIFIED JPEG ALGORITHM USING A NOVEL DISCRETE SINE OF COSINE TRANSFORM (DSOCT)

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Abstract
There are various representations of information to communicate with each other such as text, image, audio and video. In broadcasting any message, there are two ways to communicate. The first way is to record some information and transmit it through antenna. The second way is to transmit the live information through antenna. In both cases the size of the information is very necessary. In first case, we need more memory to store the information and takes more time to transmit the information. In second case, we would not require memory since there is no need of storage, but it takes more time to transmit the information. To avoid to occupy the more memory for holding information and to reduce the time taken to transmit the information, image compression is required. The first part of the paper deals with the existing JPEG Algorithm which uses Discrete Cosine Transform. The second part of the paper deals with the Modified JPEG Algorithm which uses Discrete Sine Transform and compare it with the JPEG Algorithm with Discrete Cosine Transform. The final part of the paper deals with the Modified JPEG Algorithm which uses Novel Discrete Sine of Cosine Transform and compare it with the JPEG Algorithm with Discrete Cosine Transform

Introduction
The various types of information are text, image, audio and video. Text contains alphabetical words, numerals, and special characters. Image is defined as the matrix in which each element of the matrix contains the pixel information. Image is the 2D information and retrieves this type of image by visually. Audio is defined as the 1D signal which will get the information though voice by mike and retrieve the audio information through hearing. Video is also the image which is arranged sequentially.
JPEG algorithm compress the image with very low loss in quality. The paper [3] compress the image by taking 2D DCT, which is used to extract spatial frequency information from the spatial amplitude samples. These frequency components are quantized, and encoded (Run Length Coding and Huffman Coding). This paper produces the compressed image with PSNR value vary from 28 to 37.
The paper [1] also compresses the image by taking 2D DCT. But here in order to compute the DCT operation faster, this paper uses Fast 2D DCT technique. Generally in JPEG algorithm process, Run length coding and Huffman Encoding is used. The paper [2] uses the new entropy encoding algorithm in which most of the energy is compacted into low frequency coefficients and that many of the high frequency coefficients are zeros. This paper achieves PSNR value for compressed image as 41.5954.

Existing work
Figure 1 shows the Block Diagram of the JPEG Compression Techniques using Discrete Cosine Transform. The original image is transformed using Discrete Cosine Transform, in which spatial amplitudes is transformed into spatial frequency components. Then all the frequency components are quantized by means of quantization. After quantization encode the image using run length coding and Huffman coding.
The discrete cosine transform of the Image $I(x,y)$ is given by

$$I_t(p,q) = \alpha_p \alpha_q \sum_{x=0}^{M-1} \sum_{y=0}^{M-1} I(x,y) \cos\left(\frac{\pi(2x+1)p}{2M}\right) \cos\left(\frac{\pi(2y+1)q}{2N}\right)$$

where

$$\alpha_p = \frac{1}{\sqrt{M}} \quad for\ p = 0$$

$$\alpha_p = \sqrt{\frac{2}{M}} \quad for\ 1 \le p \le M-1$$

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$$\alpha_q = \frac{1}{\sqrt{N}} \; for \; q = 0$$

$$\alpha_q = \sqrt{\frac{2}{N}} \; for \; 1 \le q \le M-1$$

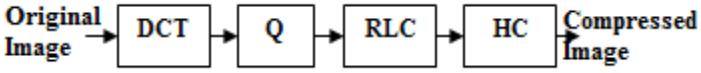

Figure 1 JPEG Compression using DCT

Proposed works

JPEG compression using discrete sine transform

Figure 2 shows the Block Diagram of the JPEG Compression Techniques using Discrete Sine Transform. The original image is transformed using Discrete Sine Transform, in which spatial amplitudes is transformed into spatial frequency components. Then all the frequency components are quantized by means of quantization. After quantization encode the image using run length coding and Huffman coding.

The discrete cosine transform of the Image $I(x,y)$ is given by

$$I_t(p,q) = \sum_{x=0}^{M-1}\sum_{y=0}^{M-1} I(x,y) \sin\left(\frac{\pi(x+1)(p+1)}{M+1}\right) \sin\left(\frac{\pi(y+1)(q+1)}{N+1}\right)$$

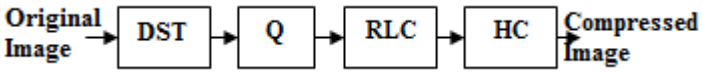

Figure 2 JPEG Compression using DST

JPEG compression using discrete sine of cosine transform (DSOCT)

Figure 3 shows the Block Diagram of the JPEG Compression Techniques using Discrete Sine of Cosine Transform. The original image is transformed using Discrete Sine of Cosine Transform, in which spatial amplitudes is transformed into spatial frequency components. Then all the frequency components are quantized by means of quantization. After quantization encode the image using run length coding and Huffman coding.

The discrete cosine transform of the Image $I(x,y)$ is given by

$$I_t(p,q) = \alpha_p \alpha_q \sum_{x=0}^{M-1}\sum_{y=0}^{M-1} I(x,y) \sin\left(\cos\left(\frac{\pi(2x+1)p}{2M}\right)\right) \sin\left(\cos\left(\frac{\pi(2y+1)q}{2N}\right)\right)$$

where

$$\alpha_p = \frac{1}{\sqrt{M}} \; for \; p = 0$$

$$\alpha_p = \sqrt{\frac{2}{M}} \; for \; 1 \le p \le M-1$$

$$\alpha_q = \frac{1}{\sqrt{N}} \; for \; q = 0$$

$$\alpha_q = \sqrt{\frac{2}{N}} \; for \; 1 \le q \le M-1$$

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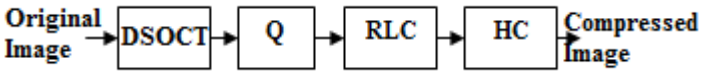

Figure 3 JPEG Compression using DSOCT

Results and discussions:

Figure 4 shows the original images which is used to test the JPEG compression technique. The four images are 'cameraman.tif', 'rice.png', 'liftingbody.png', and testpat1.png'.

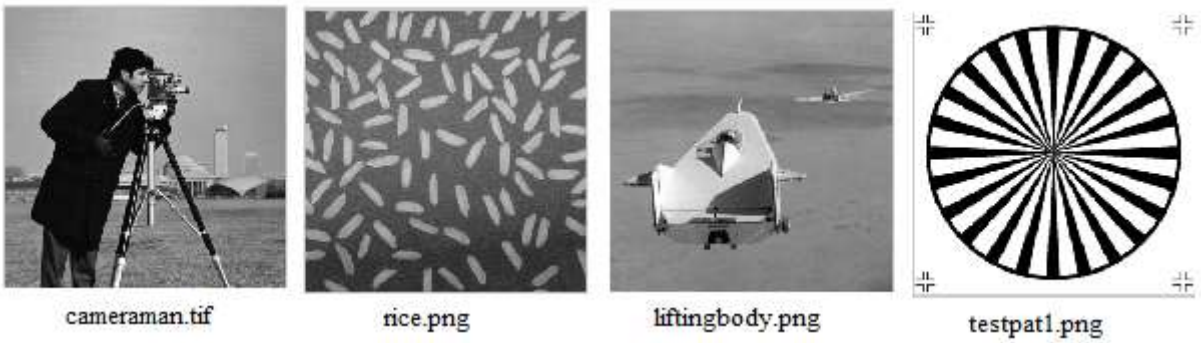

Figure 4 Original Images

Figure 5, 6 and 7 shows the compressed image of the four images shown in figure 4 using JPEG Algorithm using Discrete Cosine Transform, Discrete Sine Transform, and Discrete Sine of Cosine Transform respectively.

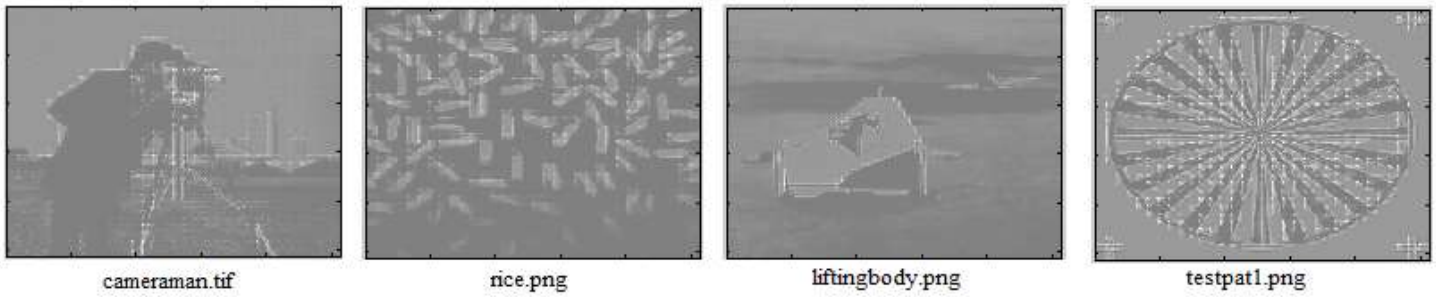

Figure 5 Compressed Image using Discrete Cosine Transform

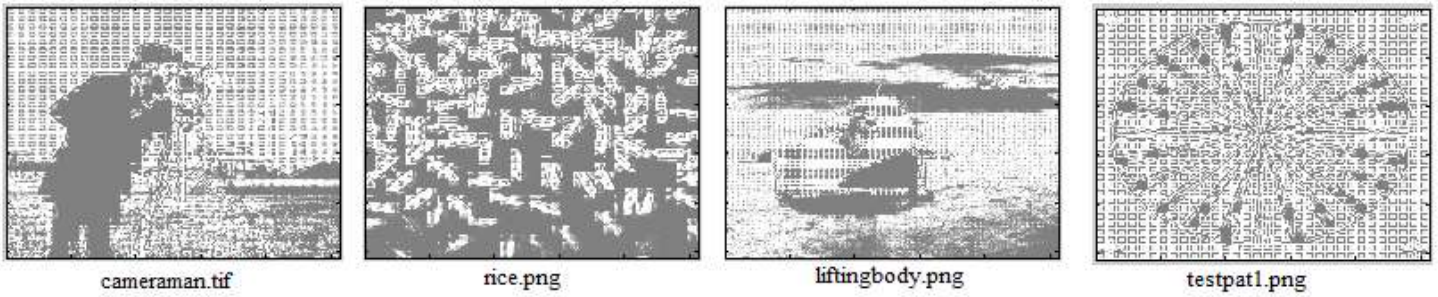

Figure 6 Compressed Image using Discrete Sine Transform

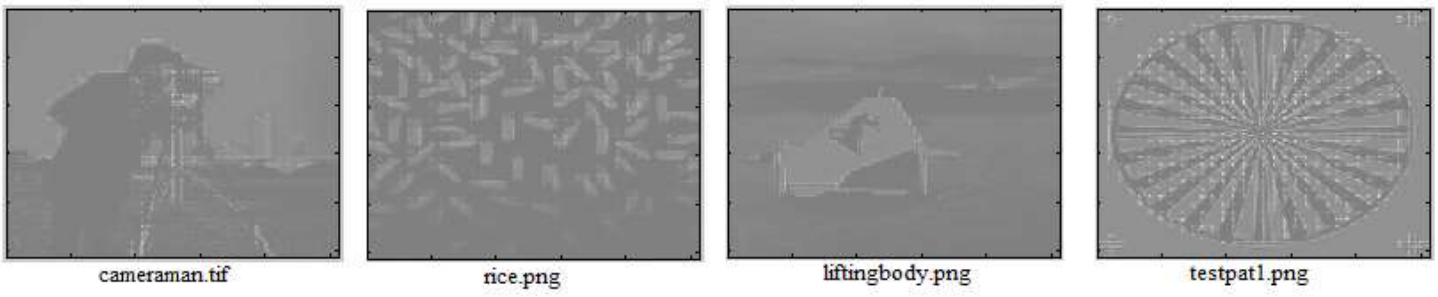

Figure 7 Compressed Image using Discrete Sine of Cosine Transform

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Table 1 shows the size and number of bits per pixel of the original and compressed image of four various images shown in figure 4 using JPEG Algorithm using Discrete Cosine Transform and compare this result with JPEG Algorithm using Discrete Sine Transform and Discrete Sine of Cosine Transform.

Table 1 Comparison of JPEG Algorithm with three different Transforms such as Discrete Cosine Transform, Discrete Sine Transform, and Discrete Sine of Cosine Transform

Method	Image	Types of Image	Size	Average Number of bits per pixel
JPEG using DCT	Cameraman.tif	Original	655360	10
		Compressed	176060	2.686
		Recovered	655360	10
	Rice.png	Original	655360	10
		Compressed	146950	2.242
		Recovered	655360	10
	Liftingbody.png	Original	2621200	9.999
		Compressed	608330	2.321
		Recovered	2621440	10
	Testpat1.png	Original	500150	7.632
		Compressed	189460	2.891
		Recovered	655360	10
JPEG using DST	Cameraman.tif	Original	655360	10
		Compressed	295420	4.508
		Recovered	655360	10
	Rice.png	Original	655360	10
		Compressed	233050	3.556
		Recovered	655360	10
	Liftingbody.png	Original	2621200	9.999
		Compressed	1185230	4.521
		Recovered	2621440	10
	Testpat1.png	Original	500150	7.632
		Compressed	302300	4.613
		Recovered	655360	10
JPEG using DSOCT	Cameraman.tif	Original	655360	10
		Compressed	159460	2.433
		Recovered	655360	10
	Rice.png	Original	655360	10
		Compressed	137340	2.096
		Recovered	655360	10
	Liftingbody.png	Original	2621200	9.999
		Compressed	524530	2.001
		Recovered	2621440	10
	Testpat1.png	Original	500150	7.632
		Compressed	183520	2.8
		Recovered	655360	10

Figure 8 shows the compression ratio in y axis with various images in x axis using JPEG algorithm using Discrete Cosine Transform, Discrete Sine Transform, and Discrete Sine of Cosine Transform. From figure 8, it is clear that JPEG algorithm using Discrete Sine Transform has less compression ratio than Discrete Cosine Transform and JPEG algorithm using Discrete Sine of Cosine Transform has higher compression ratio than Discrete Cosine Transform.

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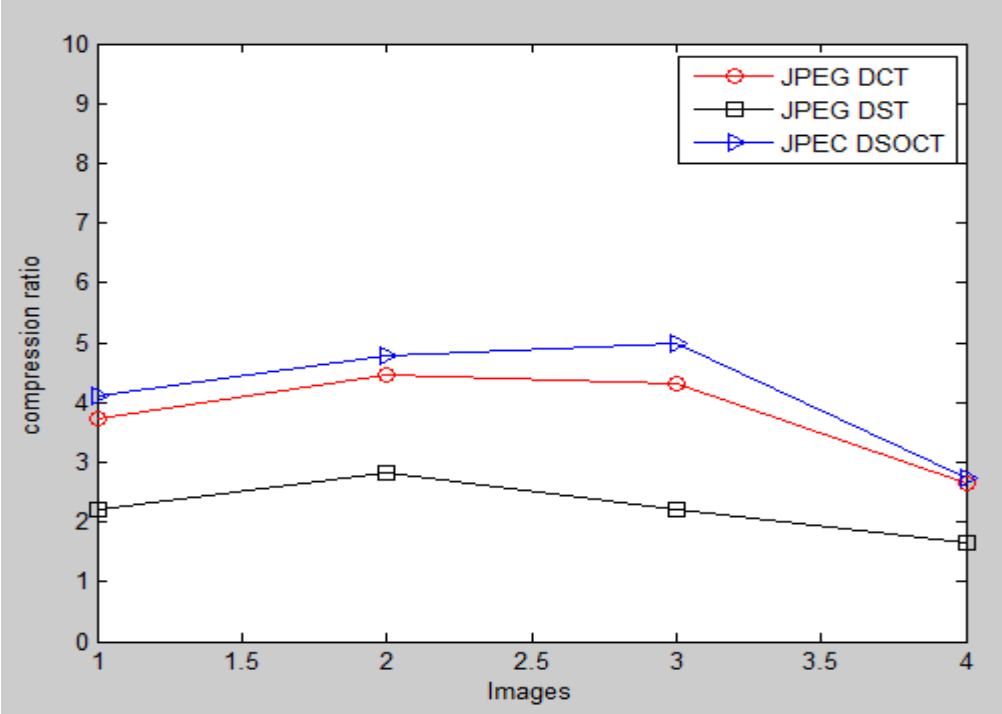

Conclusion

Thus JPEG algorithm for Image Compression using Discrete Sine of Cosine Transform has higher compression ratio than JPEG algorithm using Discrete Cosine Transform and Discrete Sine Transform.

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