

Verification of Cosine Transformation of Image Coordinates Model

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Abstract – Cosine Transformation on Image Coordinates (CTIC) is compression and decompression technique for reduced loss of compression and decompression over Discrete Cosine Transform (DCT). In this research work, the results of CTIC experiment have been verified using a testing image. It has been found that earlier researchers' claim of loss reduction is not as sufficient as it was claimed by them.

Keywords: Image, Compression, Decompression, DCT, CTIC

INTRODUCTION

Data compression is an essential process for efficient communication. Compression of data before transmission makes lower utilization of channel bandwidth as well as less time consumption of data packets or frames to be travelled over the communication medium toward destination end (Carpentieri, 2018). Compressed data should be decompressed to get the original data by receiver at destination end. It is more practical for image transmission since image sizes are usually larger than text data. Discrete Cosine Transform (DCT) was invented by N Ahmed (Ahmed 1974). It was found that DCT compression makes image loss 81.44% after decompression. To overcome this image loss, Cosine Transformation of Image Coordinates (CTIC) model and algorithm was proposed. CTIC showed that proposed method reduced image loss from 69.12% to 7.31% on an average (Al-Aziz and Muntakim; 2020).

The aim of this research is to conduct the experiment again and verify the image loss.

LITERATURE REVIEW

Discrete Cosine Transform (DCT) was invented by N Ahmed (Ahmed 1974). In DCT implementation, an image is divided by some 8×8 blocks. Each block is compressed separately by following algorithm: $F(i, j) = \frac{1}{4} C(i)C(j) \sum_{x=0}^7 \sum_{y=0}^7 P(x, y) \cos \frac{(2x+1)i\pi}{16} \cos \frac{(2y+1)j\pi}{16}$ where, $C(i), C(j) = \frac{1}{\sqrt{2}}$ for $i, j=0$ and $C(i), C(j) = 1$ for all other values of i and j . And, $F(i, j) = \frac{1}{4} \sum_{i=0}^7 \sum_{j=0}^7 C(i)C(j)F(i, j) \cos \frac{(2x+1)i\pi}{16} \cos \frac{(2y+1)j\pi}{16}$ where, $C(i), C(j) = \frac{1}{\sqrt{2}}$ for $i, j=0$ and $C(i), C(j) = 1$ for all other values of i and j . In order to reduce the time complexity of DCT, CTIC algorithm has been proposed by (Al-Aziz and Muntakim, 2020) which has two important features: there is no division of image into blocks and whole image is applied by cosine transformation linearly which reduced the time complexity.

METHOD

The main characteristic of CTIC model is, it deals with RGB image rather single channel gray image.

Sender End:

RGB color image is split into three separate channels Red, Green and Blue.

CTIC algorithm is carried out taking each channel of RGB image as input.

After CTIC algorithm carried out over three separated channels, they are merged together to form a single file and transmitted over communication channel

Receiver End:

Received image is split again

CTIC algorithm for inverse transformation is applied taking separated Red, Green and Blue channels again.

Retransformed image channels are merged together to form the original image (Al-Aziz and Muntakim; 2020).

Algorithm for compression:

```
[m n] ← sizeof(original image)
Split the color channels, apply following loops
each individual channel
For i=1 to m do
    For j=1 to n do
        P(i,j) ← P(i,j)/100
    End For
End For
For i=1 to m do
    For j=1 to n do
        F(i,j) ←
P(i,j)*cos(2*π*i)*cos(2*π*j)
    End For
End For
```

Algorithm for decompression:

```
[m n] ← sizeof(compressed image)
Split the color channels, apply following loops
each individual channel
For i=1 to m do
    For j=1 to n do
        P(i,j) ←
F(i,j)/(cos(2*π*i)*cos(2*π*j))
    End For
End For
For i=1 to m do
    For j=1 to n do
        P(i,j) ← P(i,j)*100
    End For
End For
```

EXPERIMENT AND RESULT

A computer machine with Intel Pentium P 6200, 2.13 Gigahertz Microprocessor and 2 Gigabyte DDR 3 RAM was used. Matlab Version 7.12.0.635 (R2011a) was used for experiment. The experiment was carried out using popular 'Lenna' image. After decompression, it was found that Lenna image had 86.94% similarity to the original image i.e., it has loss of 13.06%. Similarly, Peak Signal to Noise Ratio (PSNR) is 19.864 and

Energy Compaction Ratio (ECR) of three different channels R, G and B are 575.32, 775.97 and 661.36 respectively. PSNR is calculated 10 multiplied by the ratio of R^2 and MSE where MSE is the Mean Squared Error of image pixels and R is maximum fluctuation in input image pixels. ECR is calculated dividing arithmetic mean by geometric mean of the image pixels.



Figure 1: Lenna



Figure 2: Lenna after compression and decompression using CTIC algorithm

CONCLUSION

Since Peak Signal to Noise (PSNR) is 19.864 and Energy Compaction Ratio (ECR) of three different channels R, G and B are 575.32, 775.97 and 661.36 respectively, it can be said that it is very close to earlier results shown by earlier research (Al-Aziz and Muntakim; 2020). But it has been found that CTIC model has 13.06% loss which is higher than 7.31% average loss of CTIC model. However, it is subject to further improvement for lossless compression and decompression

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