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Fractal Image Compression using Region of Interest (ROI)

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Abstract—*Region of interest is defined as identifying the small portion of image or datasets. Region of interest (ROI) is used for detecting the affected portions from fractal images. It is very difficult to send huge amount of information in limited communication channel. Hence ROI method becomes for sending particular portion of information which is affected by disease. By using ROI method we are sending small amount of information of fractal image instead of sending whole information. In this work information is extracted through JPGE image. It contains two basic blocks such as compressed block and decompressed block. DCT transformation is applied on image for separating high intensity and low intensity values. Then entropy values for encoding and decoding are calculated for measuring the speed of data to be sent through the communication channel. The concept of Huffman Coding is used to reduce the image information. Finally Mean Square Error, Peak Signal to Noise Ratio and Compression Ratio are calculated to validate the proposed methodology.*

Keywords: *Region of interest (ROI), discrete cosine transform (DCT), Entropy, Compression block, Decompression block, Mean Square Error, Peak Signal to Noise Ratio, Compression Ratio.*

1. INTRODUCTION

1.1 Digital image compression

Digital image processing was developed in the year 1960s at Jet propulsion laboratory. At the same time digital image compression technology was developed. It contains two types of image compression technique such as lossy compression and lossless compression.

1.2 Lossless image compression

Lossless image compression technique was developed in the year 1970s.Lossless image compression is used for compressing the image without losing of data. In lossless image compression, output is as same as the original image. Lossless image takes more storage space in memory. Therefore it is very difficult to send large amount information in small bandwidth through internet. So its cost is high and also it occupies more storage space. It contains some image file format such as tagged image file format (TIFF), portable network graphic (PNG), bitmap (BMP) and graphics interchange format (GIF) etc. Tagged image file format is used in printing and publishing industry. It occupies huge amount of information but it supports all types of data to be compressed or decompressed. So it is used rarely in image compression application. Portable network graphic is graphical images such as web applications and web pages. It can enhance the quality of images and modified the image in some extends but it does not support any animation images. Bitmap is used for storing and creating computer graphics image. In bitmap, image can be broken into small unit of pixels then we can see the color of each pixel of an image. Then each pixel is stored in bit format. Graphics interchange format is used in World Wide Web and also it is used for animation image. But it supports only 255 colors. Hence there is a restriction for high quality of images or photograph which is beyond 255 color format.

1.3 Lossy image compression

In the year 1980s more popular image compression technique was developed that is lossy image compression. Lossy image compression is defined as the compression of data by slightly losing of information. It holds less amount of memory. Therefore it is very easy to send large amount of information in small bandwidth through internet. So its cost is low and also it occupies less storage space. It is more popular due to its support in multimedia files such as video file, audio files and image. It contains image file format such as joint photographic expert group (JPEG).Joint photographic expert group was developed in the year 1986. Now a day Joint photographic expert is popular due to high compression ratio, image quality and sharp information of an image.

1.4 Fractal image and Fractal Dimension

Fractal came from fractus means broken into small parts. Fractal image is defined as rough geometric structure which is divided into small parts; each small part is a copy of entire

image such as lyaunov fractal, newton fractal, mandelbort set, Julie set, iterated function system and burning ship fractal etc. Fractal dimension is used for measuring the depth of fractal images. Fractal dimension is of different types such as hausoff dimension, correlation dimension, information dimension and box counting dimension etc. Fractal dimension is used for designing the mathematic models and equation for an image.

1.5 Reduction Methods

Fractal image compression contains two methods such as psych-visual redundancy and statistical reduction. Psych-visual reduction is defined as the hidden information of an image which cannot be identified by human eye. Psych-visual reduction method is used in lossy image compression technique. The hidden information may be pixel value, binary value or RGB color information of an image. Statistical redundancy is defined as the representation of pixel values. Statistical reduction is divided into two types such as code redundancy and inter-pixel reduction. Code redundancy is represented as pixel value in the form of coding. Similarly Inter-pixel is defined as the relationship between the nearest pixels of an image. Statistical reduction method is used in lossless image compression technique.

1.6 Region of interest

Region of interest is defined as small portion of image or dataset for identifying the particular problem. Dataset are divided into four types such as 1 Dimensional dataset or waveform, 2 Dimensional dataset or image, 3 Dimensional dataset or volume and 4 Dimensional dataset or volume. When dataset contain frequency or time data in form of graph is called 1 Dimensional dataset or waveform. For example points. 2 Dimensional dataset or images contain dataset in the form of boundary, such as line, curve and image etc. 3 Dimensional dataset is defined as physical objects which contain surface, shape or some pattern, such as fractal images, CT scan and laser scanner etc. Similarly 4 Dimensional datasets is defined as the physical objects which are changing shape with respective to time like multidimensional graphical images. Region of interest is commonly used for digital image processing for extracting small portion of information from 1 Dimensional, 2 Dimensional, 3 Dimensional or 4 Dimensional images. Now a day's many doctors, scientists and researchers are doing research on region of interest principle. This concept is used for finding particular area of image, mean signal intensity value, standard deviation of signal intensity, maximum signal intensity value and minimum signal intensity value etc. Region of interest of an image is more popular in medical field. Region of interest is used for detecting diseases through the medical images. Main advantage of region of interest images is used for extracting information through X-ray, Computer Tomography scan, Magnetic resonance image, ultrasound image and molecular images etc. Information contains brightness or intensity values for pixels. Image may be gray scale or color. Gray scale image means it contains data in form of monochromatic or dichromatic in nature. Monochromatic means single value changes in an image. Single value means it may be either black or white. Dichromatic mean changing two values simultaneously. Two values may be black and white. Gray scale image is more popular for medical images. Color image means changing three values simultaneously. Three values may be red, green and blue. Color image is also known as RGB image or tricolor image.

1.7 Motivation

In this digital world, it is very difficult to send huge amount of data through the limited storage space. Industry, hospital, military and social network basically use information in the form of picture, graphics and animated manner. So storage space and communication channel for these information become a big task. Combining of large data, transmitting or storing for huge amount of digital image is major challenge. By using image compression technique we can solve maximum of the problem above mentioned. Now a day compression techniques is used in many application such as remote sensing, video conference, medical image and documents. This thesis is mainly focused on medical images with disease detecting method by using small amount of memory space for storing information.

2. PROPOSED METHODOLOGY

2.1 Encoding algorithm

Step1: Read the input image on the mat-lab workspace

Step2: Convert the input image from RGB to YCbCr format

Step3: Input image is divided into rectangular shape which is not overlapped with each other. Divide each rectangular shape into number of square of size 8*8.

Step4: Apply level shifting on each square.

Step5: Apply discrete cosine transformation on each 8*8 blocks.

Step6: Apply quantization on each block for separating AC and DC coefficient values.

Step7: Extract values in zig-zag manner

Step8: Huffman coding is applied on AC and DC coefficient values for finding the probability of symbols.

Step9: Extract particular place by using Region of interest (ROI)

Step10: Find the percentage of RGB colors channel

Step11: Calculate the entropy of Region of interest (ROI)

2.2 Decoding algorithm

Step1: Read the compressed the image on the mat-lab workspace

Step2: Huffman coding is applied on AC and DC coefficient values for finding the probability of symbols

Step3: AC and DC coefficient values is extracted on the zig-zag manner

Step4: Apply de-quantization on the each block for separating AC and DC coefficient values

Step5: Apply inverse discrete cosine transform on each 8*8 blocks

Step6: Apply level shifting each square blocks with 8*8

Step7: Merged all 8*8 blocks into get original image

Step8: Convert image from YCbCr to RGB format

Step9: Extract particular place by using Region of interest (ROI)

Step10: Find the percentage of RGB colors channel

Step11: Calculate the entropy of Region of interest (ROI)

2.3 Flow Chart

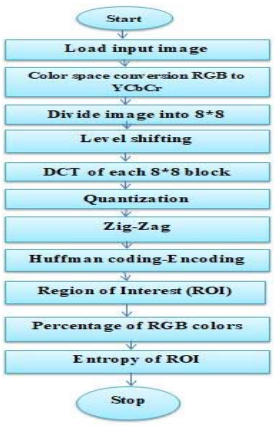

Fig. 1: **Encoding block (Compressed image)**

Fig. 2: Decoding block (decompressed image)

3. RESULT AND SIMULATION

3.1 system specification

System specification includes-

a) Software specification

b) Hardware specification

Minimum Software requirements

- Mat-lab 2015
- Microsoft Excel

Minimum Hardware requirements

- Intel processor
- 4 GB RAM
- 32 bit/64 bit Operating System

We have taken an image of size 256x256 as input and the corresponding histogram is determined. The input image and histogram are shown below.

3.2 Calculation Parameters

• Bit rate=frequency *Bit length

• Compression ratio (CR) = Original image / Compression Image

• Mean Square Error (MSR) =1/N*M ∑(x1 –x2)2

X1=Original image value

X2=Reconstruction image value

N=Number of row

M=Number of column

• Peak Signal to Noise Ratio (PSNR)

= 10 log10 ((2552*3)/ $\sqrt{mse(R)} + mse(G) + mse(B)$) db

R-Red color (Luminance value)

G-Green color (Cb value)

B-Blue color (Cr value)

3.3 Output

3.3.1 Encoding Entropy

Probability encoding= [0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.05 0.05 0.05 0.05 0.05];

entropy1 = -sum (Probability encoding.*log2 (Probability encoding))

= 6.1160 db

3.3.2 Decoding Entropy

Probability decoding = [0.3 0.03 0.03 0.03 0.03 0.03 0.03 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02];

entropy2 = -sum (Probability decoding.*log2 (Probability decoding))

= 5.4953 db

3.4 Encoding color image

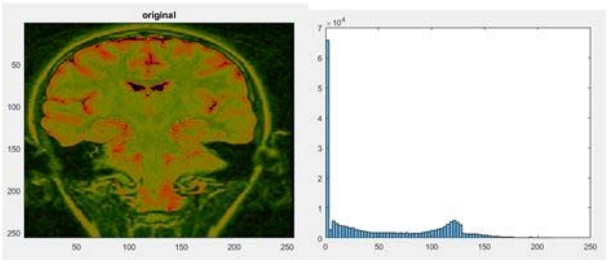

Fig. 3. Input Color image (12.2kb) and histogram of Color image

3.4.1 Region of interest (ROI) for encoding color image

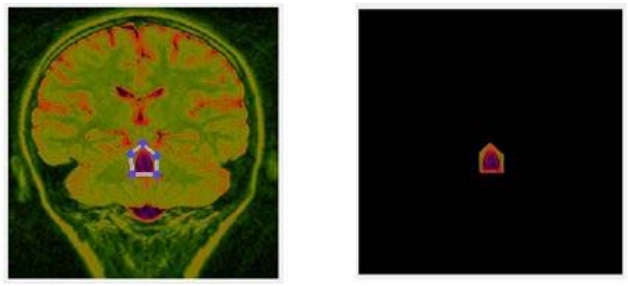

Fig. 4: Sample1-ROI and binary masking for encoding color image

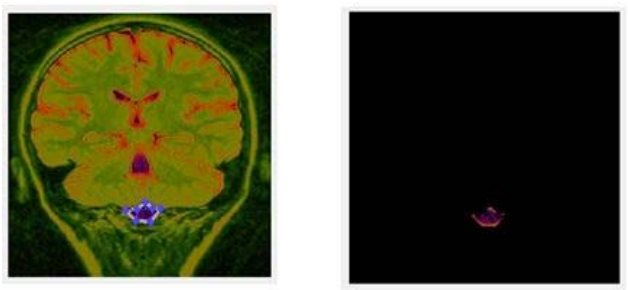

Fig. 5: Sample 2-ROI and binary masking for encoding color image

3.4.2 Calculation

A) Percentage for encoding of ROI image

R_total = sum (imgr (:))

= 51332

G_total = sum (imgg (:))

= 10415

B_total = sum (imgb (:))

=18605

I_total = R_total + G_total + B_total

=80352

Percentage of Red color

R_precentag = R_total / I_total * 100

= 63.88 %

Percentage of Green color

G_precentag = G_total / I_total * 100

=12.96 %

Percentage of Blue color

B_precentag = B_total / I_total * 100

= 23.15 %

B) Entropy for encoding of ROI image

Entropy = -sum (Probability encoding.*log2 (Probability encoding))

= 0.083 db

3.5 Decompress color image

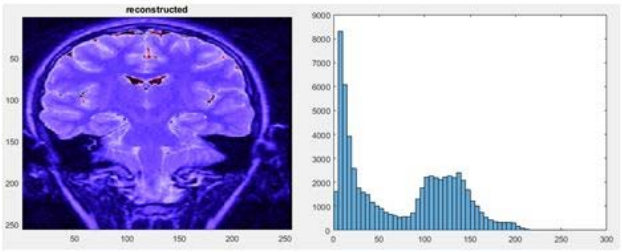

Fig. 6: Reconstruction color image (13.6kb) and histogram of reconstruction color image

3.5.1 Rigion of interest (ROI) for decoding color image

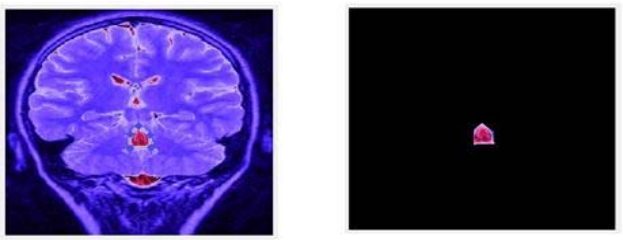

Fig. 7: Sample 1-ROI and binary masking for decoding color image

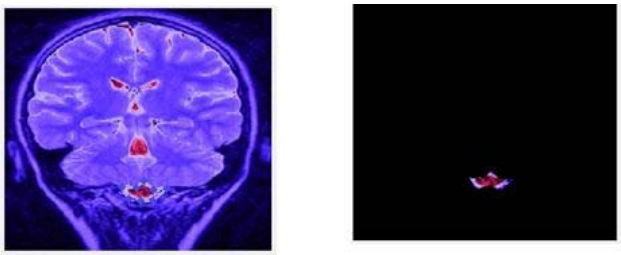

Fig. 8: Sample 2-ROI and binary masking for decoding color image

3.5.2 Calculation

A) Percentage for decoding of ROI image

R_total = sum (imgr (:))

= 40744

G_total = sum (imgg (:))

=13954

B_total = sum (imgb (:))

=2832

I_total = R_total + G_total + B_total

=83037

Percentage of Red color

R_precentag = R_total / I_total * 100

= 49.04 %

Percentage of Green color

G_precentag = G_total / I_total * 100

=16.80 %

Percentage of Blue color

B_precentag = B_total / I_total * 100

=34.12 %

B) Entropy for decoding of ROI image

Entropy = -sum (Probability decoding.*log2 (Probability decoding))

= 0.055 db

3.5.3 Parameters for compression information

A) Mean Square Error (MSR)

MSELu = sum (sum (errorlu.*errorlu)) / (256* 256);

= 0

MSECb = sum (sum (errorCb.*errorCb)) / (256* 256);

= 212.3629

MSECr= sum (sum (errorCr.*errorCr)) / (256* 256);

=0.1954

B) Peak Signal Noise Ratio (PSNR)

PSNR=10*log10 (((255^2)*3)/ (MSELu+ MSECb+ MSECr));

= 29.6272 db

C) Compression ratio (CR)

CR=Input image/reconstruction image

= 12.2/13.6 kb

= 0.89 kb

4. CONCLUSION

In this work the medical images are focused for compression because medical image contains huge amount of information. ROI concept is used for image compression to reduce the image size. In the proposed method the Mean Square Error and Peak Signal to Noise Ratio are found out. The experimental results show that the proposed method performs better in terms of compression ratio and entropy values. In future, diverse geometries for the domain blocks, probable overlapping blocks can be considered. Other than Huffman Code Data Structure can be used so that the time complexity can be minimized.

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