Design of DCT Based Constant Bit Rate JPEG Compression by Using Fuzzy Logic

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***Abstract*—In today's world the transmission of images in computer, mobile environments are increased. So the research in the field of image compression has increased significantly. Image compression plays an important role in digital image processing. In this paper image compression is done using DCT and fuzzy logic. In this method image can be compressed at desired bit rate by adjusting the quality value using fuzzy logic. In this for different quality values bit rate is achieved by the use of fuzzy logic. Fuzzy logic is conceptually easy to understand. Slant transform is complex so in this paper DCT is used for better performance and less iteration to generate constant bit rate.**

Keywords: Fuzzy logic, bit rate, DCT (Discrete Cosine Transform), JPEG.

I. INTRODUCTION

Digital images have become popular for transferring, sharing storing and visual information and hence high speed compression techniques are need among many advantages of image compression, the most important one is to reduce the time for the transmission of images. Basically these compression techniques can be categorized into the Lossy compression techniques and lossless compression techniques. Images exploit three types of redundancies:1) coding redundancy
2) Inter-pixel redundancy, 3) psycho visual redundancy. In image, coding redundancy is eliminated by variable length coding by assigning fewer bits to more probable gray values and lengthy codes to less probable gray levels. Based on these redundancies compression is grouped into lossless and lossy compression. In lossless compression only the first two redundancies are exploited. In lossy compression all the three types of redundancies are exploited. JPEG i.e. Joint photographic expert group and JPEG-2000 are used as international standards for compression. Discrete Cosine Transforms (DCT) form base line coding for JPEG and JPEG2000.

A. Compression

Compression is a method that reduces the size of files, The aim of compression is to reduce the number of bits that are not required to represent data and to decrease the transmission time, Long P.M. et al, Achieve compression by encoding data and the data is decompressed to its original form by decoding. A common compressed file extension is .sit, .tar, .zip; which indicates different types of software used to compress.

B. Decompression

The compressed file is firstly decompressed and then used. There are many software's available to decompress and it depends upon which type of file is compressed. For example WinZip software is used to decompress .zip file. The basic block diagram of Compression, Decompression And reconstructed data images is as follows.

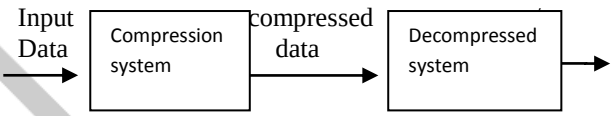

Figure1: Block diagram of compression and decompression.

C. Types of compression

1). Lossless Compression
In lossless image compression, the reconstructed image Z at the output of the decoder is exactly the same as the original image X (Fig. 1) at the input of the encoder, means the channel is errorless. One form of lossless compression is Huffman coding. In this technique, it is assumed that every pixel intensity is associated with a certain probability of occurrence and this probability is spatially invariant. Huffman coding assigns a binary code to every intensity value, with small codes going to intensities with higher probability. If the probabilities can be calculated a priori, then the table of Huffman codes can be fixed at both the encoder and the decoder. Otherwise, the coding table must be sent to the decoder along with the compressed image data. Other lossless compression techniques include run-length coding (RLC), arithmetic coding, and bit plane coding. Like Huffman coding, they also have limited compression ratios and so are used only in very sensitive applications (such as medical imagery) where loss of data is unacceptable, or used in conjunction with other methods.
2) Lossy Compression
Lossy compression is mainly used to compress Multimedia data (audio, video and still images). JPEG [6] is a still image compression standard that was developed by the "Joint Photographic Experts Group". JPEG was formally approved as an international standard in 1992. It is a lossy image compression method. It applies a transform coding method using the DCT (Discrete Cosine Transform), The effectiveness of the DCT transform coding method in JPEG relies on the major observation that the useful image contents change relatively slowly across the image, i.e., it is unusual for intensity values to vary widely several times in a small area, for example, within an 8×8 image block. Much of the information in an image is repeated, hence "spatial redundancy". Psychophysical experiments suggest that humans are much less likely to notice the loss of very high spatial frequency elements than the loss of lower frequency

elements. The spatial redundancy can be reduced by largely reducing the high spatial frequency contents.

II. IMPLEMENTATION

A. JPEG Compression Using DCT

Joint Photographic Experts Group i.e. JPEG, a standards committee that had its origins within the International Standard Organization (ISO).JPEG is a compression technique which is capable of compressing continuous-tone image with a pixel depth of 6 to 24 bits with reasonable speed and efficiency.JPEG produce very small, compressed images that are of relatively poor quality in appearance but still used in many applications. Conversely, JPEG is capable of generating very high-quality compressed images that are still far smaller than the original uncompressed image data.JPEG is a lossy method of compression.JPEG was designed specifically to remove information that the human eye cannot easily see. Slight changes in color are not understood by the human eye, while slight changes in intensity (light and dark) are not affecting the information. Therefore JPEG's lossy encoding tends to be more frugal with the gray-scale part of an image and to be more frivolous with the color.DCT divided images into different frequencies parts where less important frequencies are discarded through quantization method and important frequencies are used to retrieve the image during decompression. Compared to other input dependent transforms, DCT has many advantages:
(1) It has been implemented in single integrated circuit.
(2) It has the ability to pack most information in fewest coefficients.
(3) It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible.

B. JPEG Process

In this the original image is divided into blocks of 8 x 8. Pixel values of a black and white image range from 0-255 but DCT is designed to work on pixel values ranging from -128 to 127.Therefore each block is modified to work in the range. DCT is applied to each block by multiplying the modified block with DCT matrix on the left and transpose of DCT matrix on its right. Each block is then compressed through quantization. Quantized matrix is then entropy encoded. Reconstruction of Compressed image is reverse process. And inverse DCT is used for decompression.

III. METHEDOLOGY BY USING FUZZY LOGIC

Fuzzy Inference Systems (FIS): fuzzy set theory, which have been applied with success in many fields including compression. Their success is mainly due to their closeness to human reasoning, as well as their simplicity, which are important factors for acceptance and usability of the systems. The main modules of FIS are of particular interest: a fuzzifier, a rule base and a defuzzifier. The fuzzifier and defuzzifier have the role of trans- forming external information in fuzzy quantities and vice versa, the core of a FIS is its knowledge base, which is ex-pressed in terms of fuzzy rules and allows for approximate reasoning. The main feature of FIS is that both the antecedents and the consequents of the rules are expressed as linguistic constraints. As a consequence, a Mam-dani FIS can provide a highly intuitive knowledge base that is easy to understand and maintain, though its rule formalization requires a time consuming de fuzzification procedure. The rules used in Fuzzy inference system are:

Quality used in quantizer and corresponding encoded bit streamfunction for error rate (c) Output membership function foradaptive gain

1. If (current_error is N) and (change_error is N) then (delta_gain is PB) (1)

2. If (current_error is N) and (change_error is Z) then (delta_gain is PB) (1)

3. If (current_error is N) and (change_error is P) then (delta_gain is PS) (1)

4. If (current_error is Z) and (change_error is N) then (delta_gain is PM) (1)

5. If (current_error is Z) and (change_error is Z) then (delta_gain is Z) (1)

6. If (current_error is Z) and (change_error is P) then (delta_gain is NM) (1)

7. If (current_error is P) and (change_error is N) then (delta_gain is NS) (1)

8. If (current_error is P) and (change_error is Z) then (delta_gain is NM) (1)

9. If (current_error is P) and (change_error is P) then (delta_gain is NS) (1)

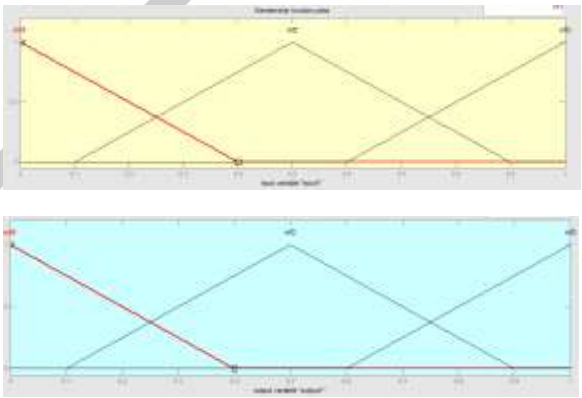

Fig.2 Input and output membership function for error

Defuzzification: Final step is converting fuzzy output to crisp output by computing the center of gravity of aggregated fuzzy set. The process of obtaining crisp output from fuzzy set Q is called defuzzification.

Q (V) has possible values of Q (1), Q (2), Q (3). . .Q(k) and its center of gravity is given by

$$Vo = \frac{\sum_{n=1}^{v} VQ(V)}{\sum_{n=1}^{v} V}$$

IV. RESULTS

Fuzzy inference maps the given inputs into an output using fuzzy logic. The mapping gives a framework from which decisions can be made. Fuzzy inference process involves membership functions, fuzzy logic operators and if-then rules. Mamdani's fuzzy inference method, which is the most commonly seen fuzzy methodology, Is used in this paper. The output membership functions is a fuzzy sets. Fuzzy membership function is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between the range of 0 and 1. The input space is sometimes referred toas the universe of discourse. The only condition a membership function must satisfy is that it must vary between the range of 0 and 1. It can have different shapes depending on the preference. In this model, triangular and trapezoid membership function is used. They simplify the required computation and are sufficient to help capture the model. The algorithm fuzzy parameters are given in fig 3.

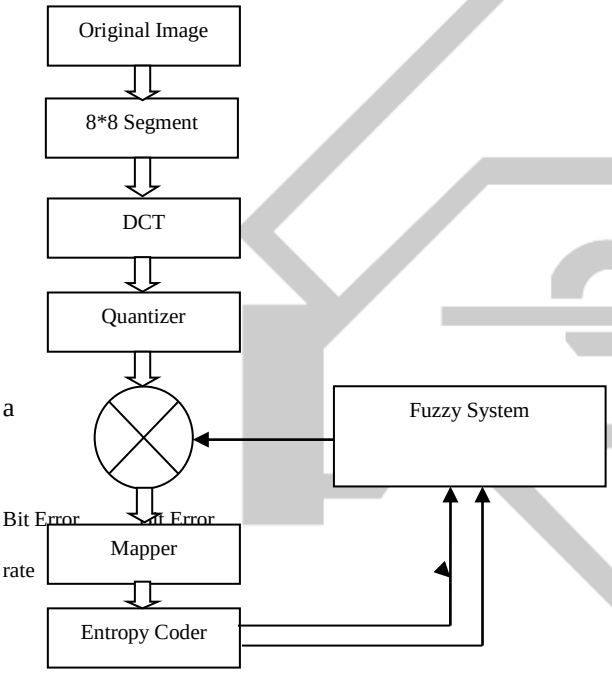

Fig. 3 Constant bit rate compressor using fuzzy logic

The input membership functions are taken as bit error and bit error rate. Previously the network is simulated with various bit error and error rates we adjust the adaptive gain keeping the output constant. Relationship between bit error, bit error rate and adaptive gain rules for fuzzy inference block are framed. The block diagram for fuzzy inference is given as shown in the figure Fig.3 The input membership functions are taken as bit error and bit error rate. Previously the network is simulated with various bit error and error rates we adjust the adaptive gain keeping the output constant manually. The data bit error, bit error rate and adaptive gain are given to adaptive fuzzy system and rules are framed. The block diagram for fuzzy inference is shown in the Fig.3 and the output of the compressor is given in the table1.

Desired Bit Rate	Constant Bit Rate	Iterations	Time (sec)
0.2	0.1904	1	1.705
0.4	0.4465	1	1.7162
0.6	0.5439	2	1.4027
0.8	0.8623	1	1.7621
1	0.9297	1	1.7462

Table1. Output of the Image Compressor

V. CONCLUTION

In this paper, DCT is used for image compression which gives better performance and easy to compute as compare to slant transform. So constant bit rate can be obtain by the use of DCT which takes less time and less iteration and gives better performance.

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