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Multimedia Data Compression Techniques

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Abstract— Integrated multimedia consist of text, graphics, audio and visual data. Data in uncompressed form requires more storage capacity and transmission bandwidth. The recent growth in web applications have not only need for efficient ways to encode signals and image but they have made compression of such signals central to storage and communication technology. Despite the technological advances in storage and transmission, the demand placed on the storage capacities and on bandwidth of communication exceeds the availability. Hence, compression has proved to be a valuable technique as one solution. The main objective of data compression is to represent the data as accurately as possible by using fewest numbers of bits. It is the process of compacting data in smaller number of bits. This paper surveys the features for image and video compression. The organization of paper as follows Section I contains the introduction part, Section II describes the component of compression, Section III covers the Compression techniques, Section IV defines the Features of Image Compression and section V describes Features of Video Compression, then the Section VI covers the benefits of compression.

Keywords— Compression, Decoding, Encoding, Lossless, Lossy compression, Spatial Redundancy, Video compression

I. INTRODUCTION

Multimedia system incorporates continuous media like voice, video and animated graphics. This implies the need for multimedia systems to handle data with strict timing requirements and at high rate. This multimedia content provides rich information to consumers, but also with information it poses challenging problems of management, delivery, access and retrieval because of its data size and complexity. Most representations of information contain large amounts of redundancy can exist in various forms. It may exist in the form of correlation spatially close pixels in an image are generally also close in value. The key to compress data is to the distinction between the data and information. Data is how information is represented; it is the physical embodiment of the information [8].

Therefore Data compression involves development of a compact representation of information. It offers technology solution for increasing the efficiencies and decreasing the cost of storing and transferring. Image and video data compression refers to a process in which the amount of data used to represent image and video is reduced to meet a bit rate requirement. Data represent information and the quantity of data can be measured. In the context of digital image and video, the data is usually measured by the number of binary units. The bit rate also known as the coding rate is important parameter in compression and is expressed in a unit of bits per second. Image compression is the application of data compression on digital images. The main objective is to reduce redundancy of image data in order to store or transmit data in efficient form. An image is essentially a 2D signal processed by the human visual system. The signals representing images are usually in analog form. An image can be described in the form of pixels [1]. The main objective of compression is to reduce the spatial and spectral redundancies as much as possible, keeping the resolution and visual quality of the reconstructed image as close to the original image. Efficient Data compression depends on the data itself. Some of the data are more commonly used and most of the compression algorithm uses this feature to gain better compression. It involves a complimentary pair of systems, a compressor (Encoder) and a decompressor (Decoder) [10]. Encoder is a device that compresses the data whereas decoder or the inverse process of compression i.e decompression is applied to on the compressed image to get the reconstructed image.

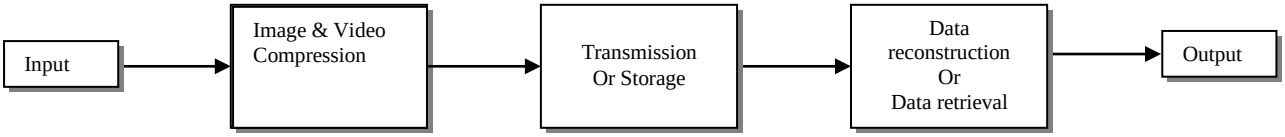


Fig. 1 Image and Video Compression for Visual Transmission and storage

The above figure shows the functionality of image and video data compression in visual transmission and storage. Both the image and video compression has been found to be necessary in these applications, since the huge amount of data involved in these and other applications usually exceeds the capability of hardware despite rapid advancements in semiconductor, computer and other related industries. Overall one can say that the original representation of data has redundancies and compressing the data reduces and eliminates these redundancies [8] and the main goal of data

compression is to represent the a source in digital form with as few bits as possible while meeting the minimum requirement of reconstruction of the original.

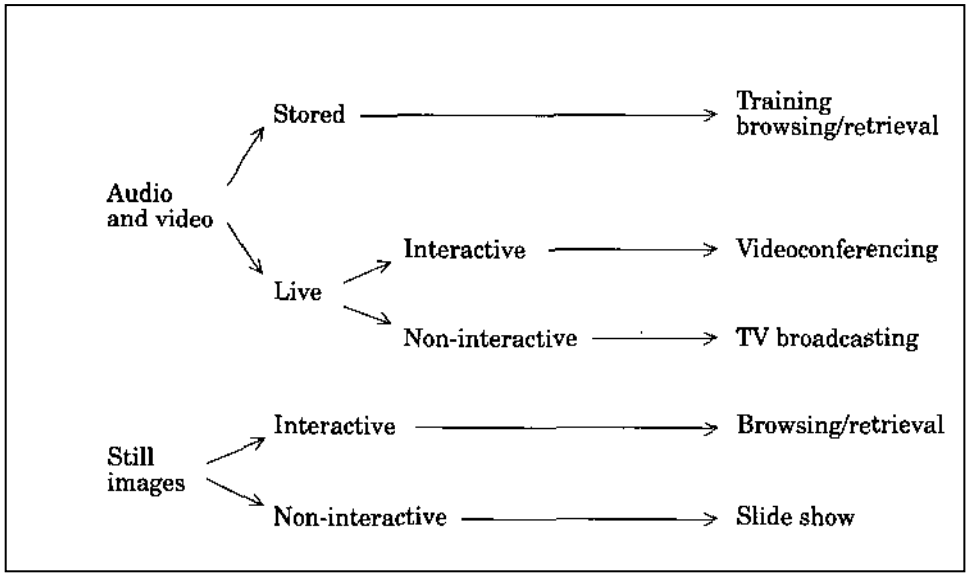


Fig. 2 Modesof operation on multimedia Data

Figure2 illustrates basic principle of dealing with Audio & video, and still images with the several operations on these media. Audio and video information can be stored and used in applications such as training, or can be transmitted live in real time. In the same way still stored images can be used in an interactive mode or in non-interactive mode.

II. COMPONENTS OF COMPRESSION

Data compression provides the solution for increasing the efficiencies and decreasing the costs of storing and transferring information. By compression, disk space to store data is reduced and disk I/O and memory usage are also reduced and thus improves the performance [3].The Redundancy and Irrelevancy reduction are the components of compression.

Through redundancy reduction the duplication is removed from the signal source (image/video) whereas the Irrelevancy reduction omits parts of the signal that will not be noticed by the signal receiver, the HVS (Human Visual System)[1]. In other words it can be state that redundancy relates to statistical property of images, where as irrelevancy relates to the viewing an image by observer [3]. Further the redundancy can be classified in following categories:-

1. Spatial Redundancy: - Elements that are duplicated within a structure, such as pixels in still image and bit pattern in a file. By exploiting spatial redundancy it is possible to reduce the image size considerably, by using a smaller number of bits.
   Thus, Spatial Redundancy is due to the correlation or dependence between neighbouring pixel values[5].
2. Spectral Redundancy: - This Redundancy is due to the correlation between different color planes or spectral bands.
3. Temporal Redundancy: - The redundancy which occurs due to the correlation between different frames in sequence of image [5].

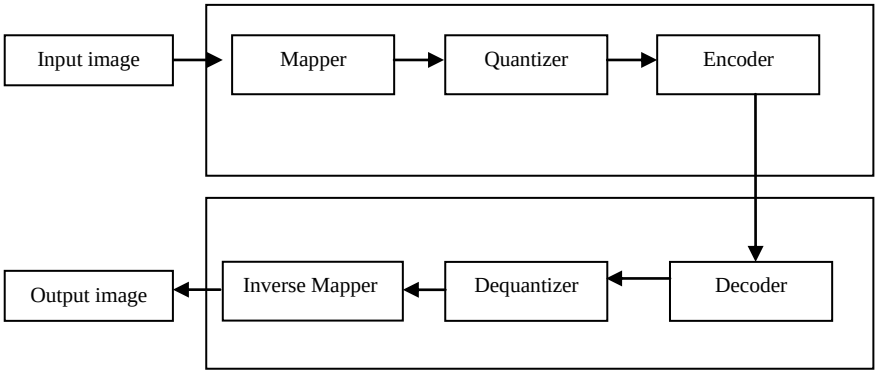


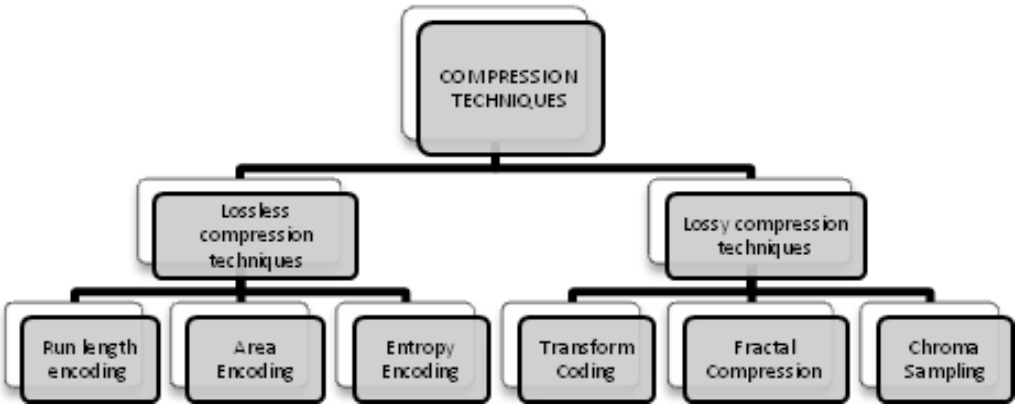
Fig. 3 Image Compression and Decompression

In the Fig. 3 encoder reduces the coding, interpixel and psycho visual redundancies if source image (input image). Further the mapper transforms the input image into a format designed to reduce interpixel redundancies. Quantizer block reduces the accuracy of mapper's output with a predefined criterion. In the final stage, a symbol decoder creates a code

for quantizer output and maps the output in accordance with the code. These blocks perform the inverse operations of the encoder's symbol coder and mapper block.

III. COMPRESSION TECHNIQUES

Compression techniques are of two types lossless and lossy. When lossless data is decompresses, the resulting image is identical to the original whereas in lossy compression there is loss of data and the decompressed images are not exactly as the original image. The following techniques of compression are:-



1. Lossless compression: - As name implies, it involve no loss of information. Data which have been losslessly compressed, can be recovered exactly in the same original form, from the compressed data. The Lossless compression is generally used for applications that cannot tolerate any difference between the original and reconstructed data [6]. Lossless compression technique is also known with the names such as entropy coding, noiseless compression etc. They will not introduce any noises to the image and uses statistics techniques to reduce the redundancy [4]. It can reduce the file size to half of the original depending on the type of file being compressed and makes the transferring of that file easier.

   Lossless image compression considers images to be sequence of pixels in row order. Processing of each pixel consists two separate operations. A first step is the prediction to the numeric value of the next pixel. Predictors basically involves combination of neighbouring pixel values and in the other step the difference between the predicted pixel value and actual intensity of next pixel is coded using an entropy coder and a chosen probability distribution[2].

For example it is used in ZIP file format and in UNIX tool GZIP. Mainly this technique is used in the cases where it is important that the original and decompressed data be identical [7]. Some image file formats PNG/GIF use only lossless compression.

1.1 Run Length Encoding:- This method is a simple compression method and mainly used for sequential data. It is useful for those data which contains the repetitive type of information. This method will replace identical symbols which are known as runs and are replaced by shorter symbols. This technique is supported by most bitmap file formats, such as TIFF, BMP, and PCX [wiki]. RLE is suited for compressing any type of data regardless of its information content, but the content of the data will affect the compression ratio achieved by run length encoding. Although most RLE algorithms cannot achieve the high compression ratios of the more advanced compression methods, RLE is easy to implement and quick to execute, making it a good alternative to either using a complex compression algorithm or leaving your image data uncompressed. There are a number of variants of run-length encoding. Image data is normally run-length encoded in a sequential process that treats the image data as a 1D stream, rather than as a 2D map of data.

1.2 Area Encoding This method is an enhanced form of run length encoding method. There is some significant advantage of using this technique over other lossless methods .In constant area coding special code words are used to identify large areas of contiguous 1's and 0's.In this the image is segmented into blocks and contains black or white pixels or blocks with mixed intensity. Another variant of constant area coding is to use an iterative approach which decomposed the binary image in smaller and smaller blocks. A hierarchical tree is built from these blocks. The section stops when the block reaches certain predefined size or when all pixels of the block have the same value. The nodes of this tree are then coded. For compressing white text a simpler approach is used. This is known as white block skipping. In this blocks containing solid white areas are coded to 0 and all other areas are coded to 1.They are followed by bit pattern.

1.3 Entropy Encoding:- Entropy encoding is another lossless compression technique. It works independent of the specific characteristics of medium. Besides using it as a compression technique it can be also used to measure the similarity in data streams. This method works as follows. It will create a unique prefix code and assign this code to unique symbol in the input. Unlike RLE entropy encoders works by compressing data by replacing the fixed length output with a prefix code word. This is of varying size after creating the prefix code. This will be similar to the negative logarithm of probability. There are many entropy coding

methods. The most common techniques are Huffman coding and arithmetic coding. Huffman coding was developed by David A. Huffman. It will use a variable-length code table for encoding a source symbol (such as a character in a file) where it has been derived in a particular way based on the estimated probability of occurrence for each possible value of the source symbol. The prefix code used in this technique is known as prefix-free codes. Encoding technique is similar to block encoding technique and it is optimal for symbol by symbol encoding. But when symbol by symbol restriction is dropped it will not be optimal.

2. Lossy compression technique: - This technique involves some loss of information and data that have been compressed using lossy technique generally cannot be covered or reconstructed exactly [6].But this scheme provides much higher compression ratios than lossless scheme. The lossy compression that produces imperceptible differences may be called visually lossless [4]. In most application, this lack of exact reconstruction is not a problem. For example when viewing a reconstruction of a video sequence, the fact that the reconstruction is different from the original is generally not important as long as the differences do not result in annoying artefacts. Thus a video is generally compressed using lossy compression.

2.1 Transform coding:-It is a type of compression for natural data like photographic images. It will result a low quality output of original image and a core technique recommended by jpeg. Transform coding is used to convert spatial image pixel values to transform coefficient values. Since this is a linear process and no information is lost, the number of coefficients produced is equal to the number of pixels transformed. Many types of transforms have been tried for picture coding, including for example Fourier, Karhonen-Loeve, Walsh-Hadamard, lapped orthogonal, discrete cosine (DCT), and recently, wavelets

2.2 Fractal Compression:- This compression technique is used in digital images. As the name indicates it mainly based on the fractals and is good for natural images and textures. It works on the fact that parts of an image often resemble other parts of the same image. This method converts these parts into mathematical data. These data are called "fractal codes". Which are used to recreate the encoded image.

2.3 Chroma sub sampling:- This takes advantage of the fact that the human eye perceives spatial changes of brightness more sharply than those of color, by averaging or dropping some of the chrominance information in the image and works by taking advantage of the human visual system's lower acuity for color differences than for luminance. It is mainly used in video encoding, jpeg encoding etc. Chroma subsampling is a method which stores color information at lower resolution than intensity information. The overwhelming majority of graphics programs perform 2x2 chroma subsampling, which breaks the image into 2x2 pixel blocks and only stores the average color information for each 2x2 pixel group.

IV. FEATURES FOR IMAGE COMPRESSION

The objective of image compression is to reduce the number of bits. It needs to represent an image by removing spatial and spectral redundancies as much as possible while also keeping the resolution of image similar or close to the original image. The decoding or decomposition is the inverse process applied to the compressed data to get reconstructed image. In image if each pixel represents unique information, then it would be difficult to compress an image. Main task is to find less correlated represented of image and thus by using the compression technique we can compressed any image.

(a)  (b) 

Fig 4. (a) Original Flower image (b) Reconstructed Flower Image to show Blocking effect

Joint Photographic Expert group (JPEG) is an excellent way to store 24-bit photographic images, such as those used for imaging and multimedia applications.JPEG was designed to compress, color or gray scale continuous tone images of real world subjects or any graphics and the vector graphics do not get compress under JPEG.

V. FEATURES FOR VIDEO COMPRESSION

Video is a sequence of digitized pictures, is also referred to as moving pictures and term frame and picture are used interchangeably. In video compression, the compression of video stream is performed. Video streams like successive images which are highly interrelated. The technique that is used to exploit the high correlation between successive frames is to predict the content of many of the frames. Instead of sending the source video as a set of individually compressed frames, just a selection is sent in this form and for the remaining frames, only the differences between the actual frame

contents and the predicted frame contents are sent. This operation is known as motion estimation and with this estimation additional information is sent to indicate small differences if any, between the predicted and actual positions of the moving segments involved and then called as motion compensation.

VI. BENEFITS OF COMPRESSION

- It reduces storage requirements but also reduces the overall execution time.
- The other advantage of compression is that it also reduces the probability of transmission errors since fewer bits are transferred.
- It also provides a level of security against illicit monitoring.

VII. CONCLUSIONS

This paper discusses the compression of still pictures as well as compression of video sequences. The different compression techniques which are classified in two categories Lossy compression techniques and lossless compression technique are explained. Lossless technique decides the image without any loss of information where Lossy compression is commonly used in multimedia data like audio, video and still images. Although the compression efficiency is the most important feature in any compression scheme and his compression depends on scalability, complexity and delay factors.

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