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Compression Techniques for Different Applications of Real-Time Communication.

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Abstract:

Real-time communication, is important and its usage is explained with through compression techniques. The application with compression techniques are applied discussed in this article. There is special focus on audio, video and image compression. Matlab is used as a simulation tool image compression is performed. The results are sometimes lossy and sometimes lossless, both types for compression is applied of image. The difference can be seen clearly in results.

Key words: RTC, QOS, image compression.

Introduction:

Without transmission delays the audio and video communication that is occurred is termed as Real-time communications (RTC). Between transmission and reception RTC data and messages are not stored. , rather than broadcasting or multicasting, transmission RTC is generally a peer-to-peer communication [1]. The data transmission modes of RTC are followed below:

- Half Duplex: bidirectional single carrier or circuit the transmission is not simultaneous on the same time the data can send or received e.g. walkie-talkie
- Full Duplex: bidirectional and on a single carrier or circuit the transmission is simultaneous or on the same time the data can send or received. e.g. internet Smartphone.

The real time communication is compared with the traditional communication. Traditional communication is also a good way of communication. They provide the best effort services to the people [2].They don't distinguish between the different applications. All application requests are treated similarly and the best that can be done for all the requests is taken up. There is no consideration of any demand that some request have a stricter demands or requirements and it should be treated differently this does not occur. All requests and demands are treated similarly. But the network tries to provide the best service. On the other hand the real time communication network supports specific quality of services (QOS) demands from applications [3]. In real time communication it will not only initiate request to certain data but also demand quality of service that for which connection which quality of service is required. So the concept of quality of service of real time application is important.

Overview of Real time system

A System whose functional correctness and response time are correct is said to be a real time system [4]. First, we will discuss the time and then the functions. So it is said that only correctness of answer is not requirement, the thing that matters is that when is the answer produced.

There are two type of notion for time i.e.

- **Quantitative**: The notion include numbers is quantitative. For example, if we are coping the data from one computer to another the time required to copy the file is Quantitative.
- **Qualitative**: The notion includes words like after, before is Qualitative. For example, the calculator will compute a problem after you enter the values.

A system must have correctness of Quantitative and Qualitative time constrain to be said a real time system

Now moving to the functional correctness of the system. There are three constrains of a functional correctness.

- **Safety**: System is safe if failure doesn't lead to any catastrophic situation.
- **Reliability**: Reliability is ability to perform it's intended task under stated condition or stated duration of time

Compression

An act or the action of compressing something is called compression [5]. To reduce the large volume of anything that can be reduced without any loss of data, the act of compression is applied on it. Compression deduces the data by using an algorithm to reduce the number of bits and the data become lighter without any loss. So that it can be shared and send to anyone through any medium easily. Different data files are combined and compressed to form a data with reduced bits. Compression is used very often but the actual mean is unknown to so many people. . For example the raw data is applied to a device known as encoder. This device perform the compression [6]. The compressed data moves through the network and then is decoded by the decoder which converts back compressed to uncompressed data [7]. So, the need of compression is to reduce the storage space, reduce the bandwidth for transmission through a network and it leads to the emergence of new applications.

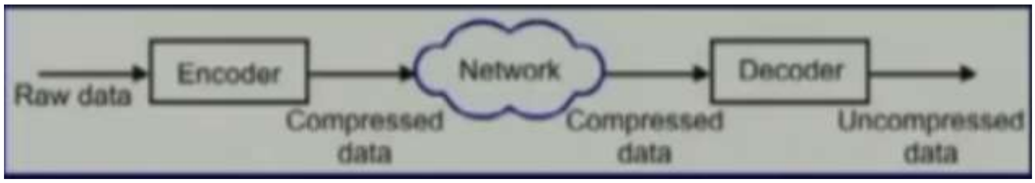


Figure No 1: Data Compression

Compression Techniques

1. Data compression

Squeezing data is called data compression. Data compression is used when we require less space in disk to store data while transferring it from one place to another. On the communication applications phone lines compression is used to improve the turnout for example modems, bridges and routers. Voice telephones calls are also compressed so that rather than using so many lines more calls can be taken on one line [8]. The applications that are used in video conferencing are essential to be compressed as they turn over the network.

At some places the data contain a lot of repetition it is repeating again and again so here it is an advantage for compression scheme to take place. For example 7 bit code represents the alphanumeric characters but by applying the compression the eight common letters can be represented by a 3 bit ASCII code.

In general, compression can be categorized into two broad or categories:

- **Lossy compression** lossy compression is the compression in which the data is compressed but with some change in the quality. The size of the data is reduced by reducing the quality of data. This reduction is not a very big loss and with this small amount of loss the data can be easily transmitted through any medium. For example, in audio and video recordings the quality loss is neglect able but size is to be compressed. The lossy technology is acceptable for the audio and video recordings or images because this loss is imperceptible to the human eye
- **Lossless compression** lossless data compression is compression in which the data is compressed and even after compression all the data is safe there is no loss. Without any loss the size of the data is reduced. In this type of compression important files and critical information is compressed. Such important things cannot afford the data loss or in which there is no space for modification lossless compression in one.

Storage system compression

Before starting with the storage system compression it is necessary to know the storage devices that store the information. Hard drives are the main storage area. Information is stored using encoding techniques and then the data is stored on it. This encoding compresses the data. The application level compression is different from encoding techniques because each file is compressed separately in application level compression.

Hard drive is an example of magnetic recording system. It stores the data by changing the magnetic field over the surface of the disk [9]. This change in field is called flux transition. In modified frequency modulation flux transition is represented by 1 digit and 0 digits are represented by the absence of the transition. Followed below are some encoding techniques that are helpful in improving the efficiency of discussed scheme:

- **Run length encoding (RLE):** Run length encoding codes represents bit patterns. With some changes it can be stored in magnetic flex which can make the MFM storage system better to almost 50%
- **Advanced run length limited (ARLL):** The patterns are converted into the code that is four times denser and stored in magnetic flux. When the patterns are converted it doubles the density of MFM recording.

2. File compression

There are different ways to compress a file today. Heavy files are compressed, so that they can be easily transmitted from one place to another. Different sources are available to compress the files in a group [10]. The group of files is compressed in a single file is easier to transmit to the sender. The various utilities that are available are PKZip and WINZip from Niko Mak computing. Anyone that has the utility can decompress a zip file. Zip file may contain a file or a group of many files. This compression of multiple files into one file is called an archive. There also exist self extracting file. These files can be extracted by anyone who does not have the utility can also open it easily. There are some operating systems that contain compression software for example DOS, Windows NT, NetWare and others. The systems that can compress the files automatically available today. But such systems should be used with care because they are not authenticated. These automated systems may not work properly and can damage the important data

3. Audio/voice compression

Perceptual encoding and predictive coding are the two types of audio compression. Predictive encoding encode the difference between the samples instead of the absolute sample values are encoded. DPCM/MDCM produces lower bit rates. This is the basic idea behind the predictive encoding. But, the quantity of compression that may be achieved through the usage of predictive encoding isn't always very excessive that’s why the perceptual encoding is more not unusual. It uses flaws in auditory system primarily based on the study of hoe human beings perceive sound. It essentially explodes the flaws of the ears, everything cannot be herd equally.

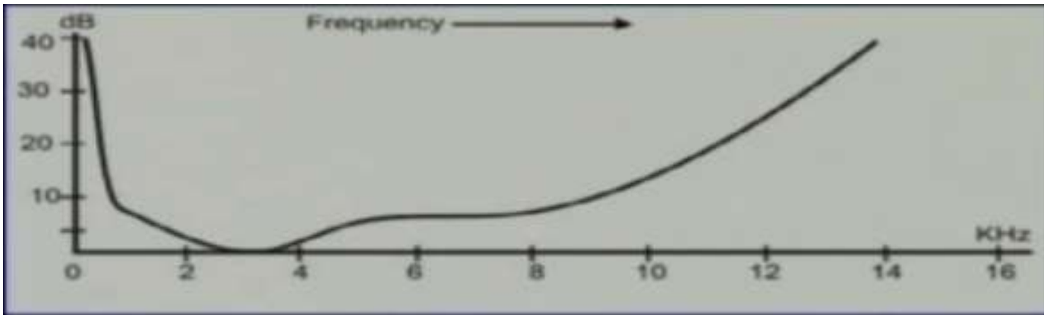


Figure No 2: Frequency Graph

The normal hearing threshold or human ear is frequency ranges from 0 to 16 KHz. Over the range from 2 to 4 KHz the human ears are sensitive. Human ears are very insensitive towards high frequency and sensitive towards low frequency. Ears sensitivity to sound is not uniform.

It has been observed that some sounds can mask other sounds. There is two type of masking one is frequency masking and the other is temporal masking. It has been observed that loud sound in a frequency range can partially or fully masks another sound in the nearby frequency range. This is called frequency masking. This occurs when a sound that we can normally hear is masked by another a nearby frequency. A loud sound can numb the human ears for a short duration even after the sound has stopped this is called temporal masking. For example if an airplane passes at that time people are unable to hear each other.

MPEG-1 Audio Compression

44.1 KHz is very common for compact disc quality for audio. The signal is converter from time domain to frequency domain conversion is performed using FFT. The ensuing spectrum is split in at most 32 frequency bands, each of which has processed separately. As an instance frequency tiers which might be to be absolutely masked are allocated small variety of bits. The frequency stages which are to be partially masked are allocated small variety of bits. on the other hand the frequency tiers that aren't to be masked are allocated longer variety of bits. In case of stereo, redundancy inherent in two notably overlapping audio resources is exploited. Whenever stereophonic sound is recorded two channels can have a lot of commonality or redundancy. The audio stream is adjustable from 32 Kbps to 448 Kbps when MPEG-1 is used [11].

4. Video/image compression

Video is an essential temporal aggregate of various frames. every frame may be taken as a photo which comprising spatial combination of pixels. There are two fundamental precept used. One is Joint Photographic specialists organization that's (JPEG) this is generally used to compress picture via casting off spatial redundancy that exists in every frame. So each frame is taken into consideration as a steel photo and unique redundancy found in it decreased with the assist of JPEG. on the other hand transferring photo experts organization that is (MPEG) is used to compress video through doing away with temporal redundancy of a fixed of frames because the distinction among two frames may be too small.

JPEG: JPEG involves the following four distinct steps

- **Block preparation:** when a video is digitalized it is converted into an array of pixels with 640x480 fixed cells and each of the pixel has RGB content. Each is represented with 8 bits so this leads to 24 bits pixel. This is how video frame is digitalized. However before performing any operation it is converted in to Luminance (brightness) or Chrominance (color) component. Human eyes are more sensitive to luminance than to chrominance. So chrominance can send with lesser resolution.
- **Discrete cosine transformation:** Each block of 68 pixels that is 8x8, goes through a transformation called DCT. This discrete cosine transform is highly mathematical.
- **Quantization**: Quantization is the third step and it further increases the number of zeros
- **Compression:** This is the last step in JPEG in which the processed data is compressed and the output is produced.

These steps are performed to generate the output to form the compressed output. The unsorted information in collected and send to the Block preparation then to discrete cosine transformation then to Quantization. After this set data is compressed and output is produced.

MPEG-1: For video compression, videos on compact disks and audio broadcasting MPEG-1 were finalized to be used. With the help of MPEG-1 the VCR quality 640x480 pixels with 25 frames per second and 24 bits pixels gives 368.64 Mbps in a uncompressed form and 1.5Mbps in compressed form. After compression it can be easily send through many networks. MPED-1 is likely to dominate the encoding of CD ROM based movies because it provides quiet good quality performance. It can be used over twisted pair for the transfer of data from one place to another. For example it can be transmitted through ADSL network. MPEG-1 has three components; audio, video. Audio compression is done when audio signal is applied to audio encoder that does compression independent to video compression. So, video signal is applied to video encoder and audio coder is applied to audio encoder after sampling. Now a 90 KHz clock is used that gives output.

MPEG-2: although MPEG-1 and MPEG-2 are basically similar, it was actually designed for digital TVs. In this case D frames are not supported because in television fast-forward or kind of update is not done. To have data clarity DCT is 10x10 instead of 8x8 that is used in MPEG-1 to provide better quality. It supports four different resolutions and two of them are HDTV and TV. It supports five different profiles and applications. Depending on the application choices are made.

MPEG-4: MPEG-4 video compression support very low bit rates MPEG-4. In MPEG-1 and MPEG-2 the techniques are concerned with the compression but apart from compression have much important functionality.

H.261: For ISDN services as a standard for digital telephone H.261 was developed. In case of ISDN services the rates are multiple of 64Kbps so after compression it is necessary to transmit at rate lower than 64 Kbps or some multiple of it. Using CIF the frame size is 352x288 there are 15 frames per second and 8 bit pixels that gives 24.33 Mbps uncompressed and 112Kbps compressed. Using QCIF the frame size is 176x144 there are 10 frames per second and 8 bit pixel that gives 4.0 Mbps uncompressed and 64 Kbps compressed.

5. Packet compression

The compression of the packet network is called packet compression. The data is travelled from source to the destination using packets. These packets contain the data that is divided into small parts so that they can be easily send to the destination. The compression of packets allows these packets of data to be compressed for a smooth and faster behavior of the application. The network packet which is compressed is divided into two parts. One of it is header and the other is play load. So, the basic packet compression can be depicted from header compression or from payload compression or may be both of them. IPzip is the algorithm that is used in the packet compression.

6. Header compression

The alarming situation when speed on the internet is slow and the rate of delay are high. Such a situation can be handled and reduced by packet headers. Packet header is a part of network packets. Small packets of data are needed at some places for transmission for example real time applications, multimedia application and remote login. The packet header of large size is prohibited on small packets. Throughout this process source code and destination address that are the header files remains constant but sequence will change. Van Jacobson Compression scheme and Robust Header Compression scheme are the two commonly used header compression schemes to overcome the packet header above the level.

Matlab as a simulation tool

Technical computing can be done easily today by using language like matlab. In this article matlab that is an attractive tool is used as simulation tool. Matlab is used for image compression here. There are different schemes for image compression in matlab for different stages in image compression scheme. Different schemes can be combined sometimes for different results; the image can be lossy or lossless.

Why do we compress an image?

Cameras are the most often used today's and advanced camera contain images of more and more mega pixels for the best results. Good quality pictures are heavier in size so it is very difficult to send them through internet as well as it is very time consuming. Due to speed limitation of internet image compression is done without degrading quality so that images are easily send or receive using limited speed internet.

Simulation

Compression methods are applied for image compression. In the first code block proc is used that produces an out of lossless compression. Blockproc is a function where a block size is defined and this function is performed on the image. Here Discrete cosine transform is performed on one block and inverse discrete cosine transform is performed on the other block.

```
close all;
t1 = @ (block_struct) dct2(block_struct.data);t2 = @ (block_struct) dct2(block_struct.data);
Pm=imread('C:\Users\Rida Zainab\Desktop\cameraman.png');
```

```
imwrite(Pm,'C:\Users\Rida
Zainab\Desktop\abc1.png');
figure,imshow(Pm);
B = blockproc(Pm, [8 8], t1);
depth = find(abs(B) < 50);
B(depth) = zeros(size(depth));
S = blockproc(B, [8 8], t2) / 255;
figure,imshow(S);
% K
B = blockproc(Pm, [8 8], t1);
depth = find(abs(B) < 50);
B(depth) = zeros(size(depth));
S = blockproc(B, [8 8], t2) / 255;
figure,imshow(S);
imwrite(S,'C:\Users\Rida
Zainab\Desktop\abc2.png');
compression_ratio= numel(B)/numel(depth);
```

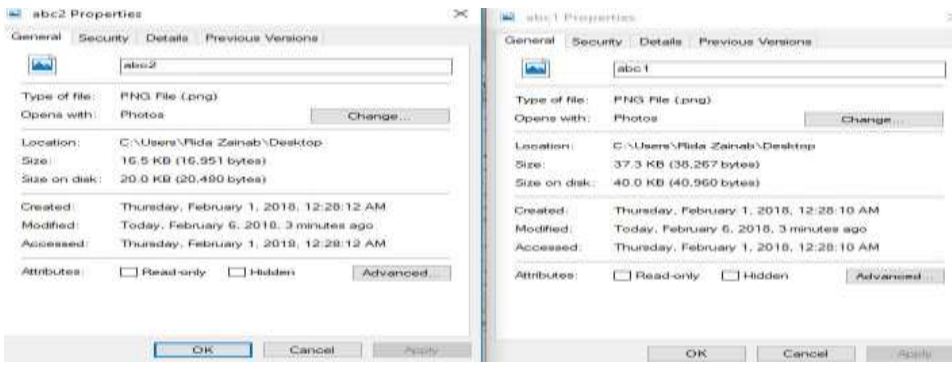
the output is

Figure No 3: Orginal Image

Figure No 4: Blurred Image

Figure No 5: Compressed Image

Here figure 3 is the original image and the compressed image. The size of original image is 37.3 KB and that of compressed image is 16.5 KB. It is a lossless image but by increasing the size of value less than J, this will cover the compression factor. When the compression size is increased and the result will be a lossy compression. By increasing the size of J from 50 to 150 the resulting image will be blunt as shown in figure 3. The compression rate is 1.02 in this image.



This is other code applies in this article for image compression.

```
close all

v=imread ('cameraman.png');
figure,imshow(v);
T=dct2(v);
figure,imshow(T*0.01);
tt = idct2(T) ;
figure,imshow(tt/255);

[r,c] = size(v) ;
DF = zeros(r,c) ;
DFF = DF ;
IDF = DF ;
IDFF = DF ;
depth = 4 ;
O = 8 ;

for z=1 : O : r
    for p=1 : O : c
        f = v(z:z+O-1,p:p+O-1);
        lf = dct2(f);
        DF(z:z+O-1,p:p+O-1) = lf ;
        lff = idct2(lf);
        DFF(z:z+O-1,p:p+O-1) = lff ;
        lf(O:-1:depth+1, :) = 0 ;
        lf(: ,O:-1:depth+1) = 0 ;
        IDF(z:z+O-1,p:p+O-1) = lf ;
        lff = idct2(lf);
        IDFF(z:z+O-1,p:p+O-1) = lff ;
    end
end

figure,imshow(DF/255);
figure,imshow(DFF);
Q=DFF/255;
figure,imshow(Q);
imwrite(Q,'C:\Users\Rida
Zainab\Desktop\abc1.png');

O=IDFF/255;
imwrite(O,'C:\Users\Rida
Zainab\Desktop\abc2.png');
figure,imshow(O);
```

Figure No 6: Screen Shot

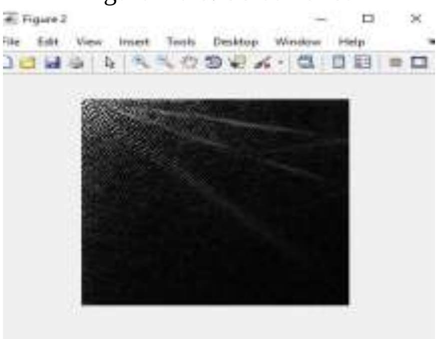


Figure No 7: Cosine Transform

Discrete Cosine Transform and the Inverse Discrete Cosine Transform is performed in this algorithm on the image. Now the result is shown above as figure is the image with Discrete Cosine Transform and figure 2 shows the output of Inverse Discrete Cosine Transform.

Now the vectors df, dff, idf and idff are created to store the values. Df will be original value DCT is performed for all these values DFF would be the inverse DCT with all the values retained. This code will produce the following outputs

Figure No 8: Original Image

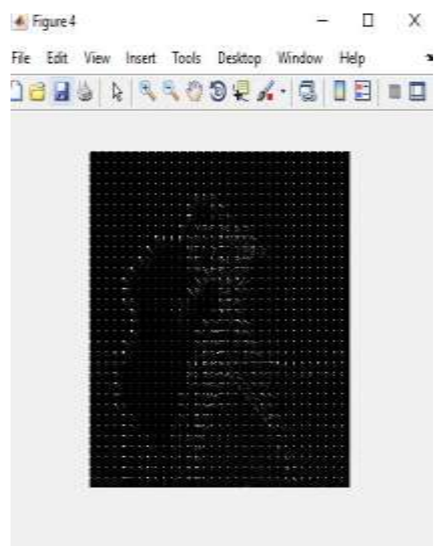


Figure No 9: Compressed Image

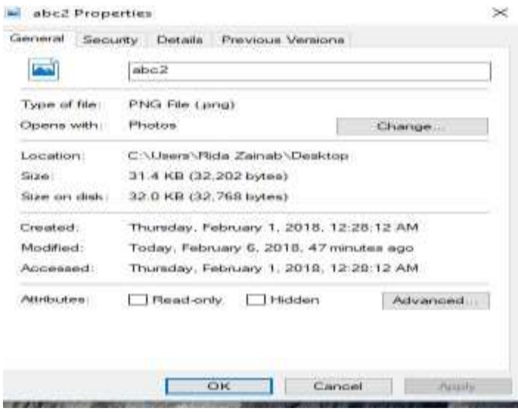
Figure No 10: Lossy Compression Image

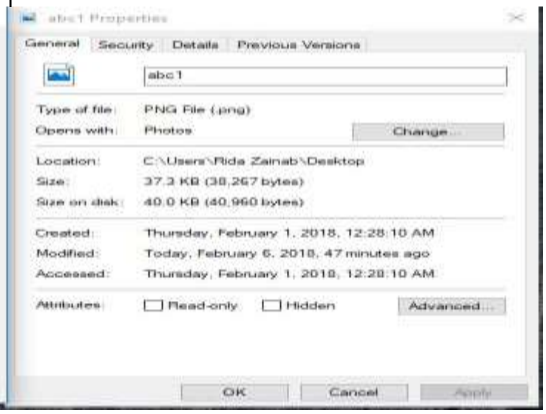
Figure 8, is an original image with no compression on it. Figure 9 and figure 10 are compressed images and this compression is a lossy compression. Figure 9 is totally black image and standing man can be seen by white dots, and figure 10 is totally white image so nothing can be seen in this image. This type is compression is of no use. So, only lossless images that are compressed, but the image is visible are good and useful.

Figure No 11: Loseless Compressed Image

Figure No 12: Less compressed Image

The compression in figure 11 and figure 12 is a lossless compression. Figure 11 is less compressed than figure 12 so both of them can easily be seen and useful for the user. Such images are easy to transmit from source to the destination. This type of compression completes the aim of image compression. Below figures show the difference between the size of figure 11 and figure 12. Figure 11 is 31.4 KB and figure 12 is 37.3 KB. This difference is very less that can be seen from images as well as from size.





Conclusion

To provide throughput on the device compression techniques are applied. Compression algorithm is necessary for compression and it must be in real time. The most important factor of compression is that it should be lossless because lossy compression is of no use. Compression is actually a way to decrease the size of heavy data without such change that can be detected by human eye. On the basis of advantages and disadvantages, the methods and techniques of compression are discussed in this article. The application like audio video data etc on which compression can be applied are discusses with their importance in our world nowadays. The applications are compressed so that the data can be easily transmitted over a network. It plays an important role in real time communication, because without compression the data of large size cannot be transmitted.

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