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CASE STUDY AND REPORT

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# An analytical study of image compression algorithms for Stereoscopic images in Non Immersive virtual reality world.

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***Abstract:*** VR will reshape the interface between people and information technology by offering new ways for the communication of information, the visualization of processes, and the creative expression of ideas. It is the collection of stereoscopic images. Now a day's transmission of such images is unavoidable when we think about virtual conference, training programmes, and some video games. In this paper I discuss about the two widely used video frame compression algorithms and compare the performance factors associate with them.

***Keywords:*** Virtual reality, immersive, no immersive, MPEG stereoscopic image compression and wavelet image compression

## I. INTRODUCTION

Virtual reality (VR) is a technology which allows a user to interact with a computer-simulated environment, be it a real or imagined one a virtual environment can represent any three-dimensional world that is either real or abstract. This includes real systems like buildings, landscapes, underwater shipwrecks, spacecrafts, archaeological excavation sites, human anatomy, These virtual worlds can be animated, interactive, shared, and can expose behaviour and functionality. The most direct experience of virtual environments is provided by fully immersive VR systems, where the user either wears an HMD or uses some form of head-coupled display such as a Binocular Omni-Orientation Monitor. Non-immersive systems are the least immersive implementation of VR techniques. Using the desktop system, the virtual environment is viewed through a portal or window by utilizing a standard high resolution monitor. Interaction with the virtual environment can occur by conventional means such as keyboards, mice and trackballs

## II. VIDEO COMPRESSION

Video and audio files can consume large amount of data and need high amount of storage. Large data needs very high bandwidth networks in transmission. That is why data are compressed. Video compression refers to reducing the quantity of data used to represent video images. Videos are compressed in order to effectively reduce the required bandwidth in transmitting digital video via terrestrial broadcast, cables/wires/fiber optics, or via satellite service.

Video compression reduced the amount of data transmitted without reducing its quality. It is at the heart of digital television set-top boxes, DVD players, video conferencing, Internet video, and other applications. These applications benefit from video compression in the fact that they may require less storage space for archived video information, less bandwidth for the transmission of the video information from one point to another or a combination of both.

Today's computer platforms require data to be compressed because of three reasons: multimedia data requires large storage, relatively slow storage devices that cannot play multimedia data in real time, and network bandwidth that does not allow real-time data transmission. High quality data video requires high data rates and more bandwidth in transmission. Video compression techniques reduce these tremendous storage requirements. Advanced techniques can compress typical image at a ratio ranging from 10:1 achieving video compression up to 2000:1.

## III. MPEG IMAGE COMPRESSION

The acronym MPEG stands for Moving Picture Expert Group, MPEG compression of the left and right components of a stereo image pair is a way to save valuable bandwidth when transmitting stereoscopic images  In order to assess the effect of compression techniques on perceived image quality, 2D objective measures such as the peak-signal-to-noise ratio (PSNR) or the mean squared error (MSE) are often used. These measures indicate the difference between the coded and original image.

Intra-frame DCT coding DCT: A two-dimensional DCT is performed on small blocks (8 pixels by 8 lines) of each component of the picture to produce blocks of DCT coefficients (Fig. 1). The magnitude of each DCT coefficient indicates the contribution of a particular combination of horizontal and vertical spatial frequencies to the original picture block. The coefficient corresponding to zero horizontal and vertical frequency is called the DC coefficient

The 2 Dimensional DCT is defined as

$$F(U,V) = \frac{2}{N} C(U) C(V) \sum_{X=0}^{N-1} \sum_{Y=0}^{N-1} F(x,y) k1 k2$$

Where k1= $\cos\frac{(2x+1)u\pi}{2N}$ and K2= $\cos\frac{(2y+1)v\pi}{2N}$

 

The inverse DCT is

$$C(u)\,C(v) = \begin{Bmatrix} \frac{1}{\sqrt{2}} For\, u, v = 0 \\ 0\, otherwise \end{Bmatrix}$$

The inverse DCT is given as

$$F(x,y) = \frac{2}{N}\sum_{X=0}^{N-1}\sum_{Y=0}^{N-1} c(u)c(v)F(u,v)k1k2$$

The x and y are special coordinates in the image block U, V are coordinates in DCT Coefficient block.

Fig 1 *The discrete cosine transform (DCT).*

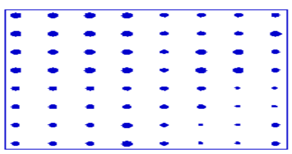

**Figure 1** 2a. 8 x 8 Image Block

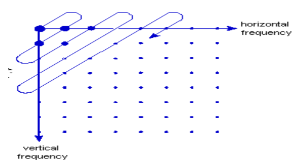


**Figure 2** 2b.8x8 DCTcoefficient Block

*Pixel value and DCT coefficient magnitude are represented by dot size.* The transmission and storage of stereoscopic image material involves a large amount of data. Therefore, a substantial research effort is focused on understanding digital image compression such as MPEG coding to obtain savings in both bandwidth and storage capacity. The same compression techniques used in two dimensional image material can also be applied separately on the left and right view of a stereoscopic image pair. When information is removed out of a single frame, it is called *intraframe* or *spatial* compression. But video contains a lot of redundant interframe information such as the background around a talking head in a news clip. Interframe compression works by first establishing a key frame that represents all the frames with similar information, and then recording only the changes that occur in each frame. The key frame is called the "I" frame and the subsequent frames that contain only "difference" information are referred to as "P" (predictive) frames. A "B" (bidirectional) frame is used when new information begins to appear in frames and contains information from previous frames and forward frames.

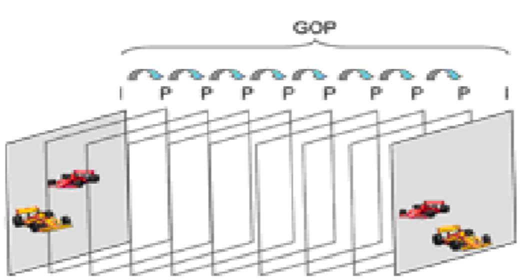


**Figure 3** Group of Picture frames

I and P frames are sent in a structured video stream known as the Group of Pictures, or GOP. Figure 1 shows the relationship of I and p frames in a GOP structure.

For inter-encoded algorithms, bit rates for acceptable quality video can drop to 1.5 to 4 Mb/s from the 30 Mb/s required for M-JPEG. For inter-frame compression standards, the output bit rate is normally expressed as an average over time, not the instantaneous bit-rate. An I - frame might require five times the bits to encode as a P-frame. A GOP structure of 1 I-frame every 0.5 second implies the I-frame uses 26% of the available bit stream and results in a burst in network bandwidth requirement twice per second. Figure 2 shows the burst nature of the bandwidth usage.

**Figure 4** frame Sequence

If you observe the above sequence of frames you can notice a large amount of similarly between the consecutive frames. This similarity is redundant information in terms of video storage. The Video Compression is possible by eliminating this redundant information from the sequence of incoming video frames and there are four important types redundancies. **Temporal Redundancy**: Correlation between consecutive frames in a video sequence. The following figure illustrates the correlation between consecutive frames. If we subtract/remove the Frame-1 from other frames, the remaining amount of data is significantly less. This is inter-frame redundancy removal, since we are subtracting one frame from another.

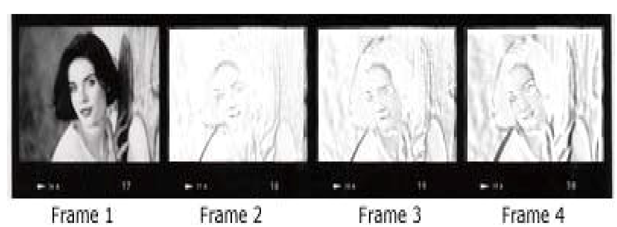


**Figure . 5** Frame after Interframe redundancy removal

Spatial Redundancy: Correlation between adjacent image pixels within the frame. Color Spectral Redundancy: The human eye's increased sensitivity to small differences in brightness and decreased sensitivity to small differences in color is taken advantage here. Physco-visual redundancy: Human Vision System is less sensitive to detailed texture in the image.

The embedded developers and researchers should have a good understanding of the various algorithms those which removes these redundancies. MPEG is a very perfect for multimedia representation and distribution, MPEG offers a variety of compression options, including low-bandwidth formats for transmitting to wireless devices as well as high-bandwidth for studio processing. MPEG is the ability of the codec to identify audio and video object in a frame. MPEG allows the separate object to be compressed more efficiently. MPEG framework includes user-controlled interactive an separately deal with audio and video files. This sequences like audio, video, text, 2d and 3d objects and animations

A wavelet is a mathematical function used in digital signal processing and image compression. In signal processing, wavelet is used to recover weak signals from noise. It is useful in processing of X-Ray and magnetic-resonance images in medical applications. In internet communication, is used to compress images to a greater extent. In some cases, a wavelet-compressed image is 25 percent smaller in size but similar in quality when using the more familiar JPEG method.

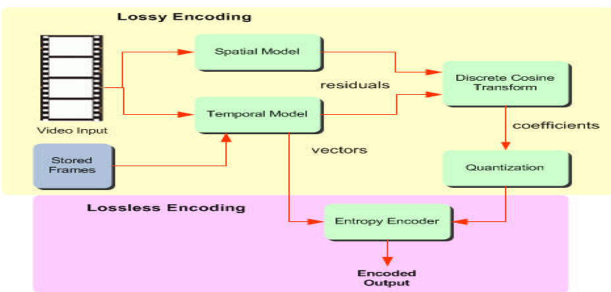


**Figure 6** Lossless and Lossy Encoding

## IV. WAVELET IMAGE COMPRESSION

For example: am image that requires 200 KB will take a minute to download using JPEG format, a wavelet-compressed format will only require 50 KB and shorter download time. Wavelet compression is not yet widely used on the internet. The most common compressed image formats are Graphics Interchange Format (GIF), which is mainly used for drawings, and JPEG, which is commonly used for photographs. A wavelet-compressed image file is given the suffix "WIF".

Wavelet compression works by analyzing and converting an image into a set of mathematical expressions that can be decoded by the receiver. It is a form of data compression well suitable for image compression. Wavelet compression can store data in as little space as possible in a file. It is one of the most effective methods in compressing image. Wavelet algorithm is based on multi resolutional analysis; this mathematical analysis is the general basis of lossless compression.

The advantage of wavelet compression against JPEG; wavelet compression analyzes the whole image without dividing it into blocks, wherein JPEG, an image is divided into blocks and each block is divided. Wavelet compression allows getting the best compression ratio, while at the same time, maintaining quality of the original audiovisual signal. Wavelet compression also supports non uniform compression, where in, a specific part of an image can be compressed more than the other.

Wavelet compression uses band pass filters to separate an image into images with low or high spatial frequencies. Low frequency images are those in which brightness change is gradual, for example, flat or rounded background areas. Such images appear soft and blurry. Higher frequency band images are crisp and sharp edged. Adding the frequency band images back together should reconstruct the original input image; perfectly if the processing is perfect.

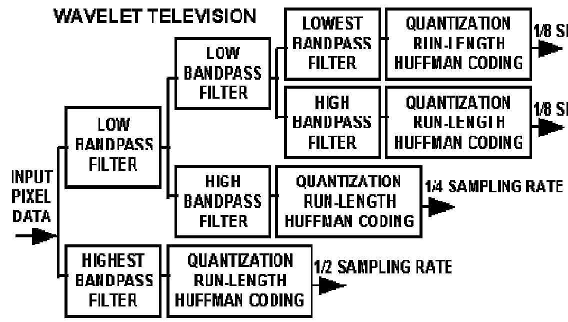


**Figure 7** .Wavelet Compression

A pixel data stream from an input image is divided into several sub-bands by a tree of band pass filters. Each filter allows only a specific band of frequencies to pass. The filters may be analog or digital, but since neither kind is perfect some image distortion can be expected even at this stage.

The process takes several steps backward before taking a step forward. We began with a single input image and now have several images, each of which requires a full measure of bits. However, since low frequency images change brightness more slowly they can be sampled at a slower rate. The sampling rate is so adjusted that the highest frequency image takes half of all samples, while each lower frequency band is sampled at a progressively halved speed. The lowest frequency image is sampled at the lowest rate. In the end, the sum of the samplings from all the frequency bands is exactly the same as the single sampling process. of the original input image. No image compression has yet been realized. Even so, some distortion will have crept in due to imperfections in the sampling

Lossy image compression is applied using a quantization threshold. Samples below the threshold are cleared to zero. The higher the threshold, the more samples cleared and the higher the compression ratio. Equally, though, the more samples cleared, the greater the image distortion and the lower the image quality. Output images are therefore only approximations of the images seen by the camera.

Output samples are further processed using Run Length coding (replacing a string of zeroes with a single number) and Huffman coding (assigning shorter bit codes to more frequent patterns). The output codes are then combined in the output data stream. Such transmissions are subject to error propagation. Even a single bit error can cause the image to break up into random noise.

Wavelet compression is lossy. It will always compromise image quality to some extent. The more images are compressed, the worse the image quality. Commercially useful compression ratios can only be achieved with significant distortion. The pattern of distortion will, of course, differ from the "checkerboard" pattern arising from the cosine transforms. But whether the overall image quality is better or worse depends on the application and individual judgment. Certainly both methods require enormous computing resources and can generally only achieve low levels of compression with acceptable image quality. Higher levels of compression come with progressively greater distortion.

## V. COMPARATIVE STUDY

Wavelet compression analyzes the whole image without **dividing it into blocks**, where in MPEG, an image is divided into blocks and each block is divided. Wavelet compression is lossy. It will always compromise image quality to some extent. The more images are compressed, the worse the image quality.

**Motion sensing** includes an automatic motion detection capability. Since it transmits only the moving portions of video images, it can be used to sense and emphasize motion or change in an image stream.

**Encoding speed, power, and system cost** Because cosine transforms and motion compensation in MPEG require enormous computation speed, only small images can be encoded at low frame rates. Encoding and compressing stereoscopic images for real time broadcast requires computer speeds beyond the present state of technology. Wavelet compression requires no conventional computing and the encoding of any sized image at up to 1000 frames-per-second should be possible. Eventually the entire system could be mounted on a single chip requiring very low power.

***IMAGE standards and compatibility problems***

The stereo image bandwidth and transmission protocols are determined by the system hardware so every new development in camera or monitor technology requires a new standard. Old recordings are difficult to convert to a new standard and may be effectively lost. In television, transmission is determined by image content which can be rendered entirely independent of system hardware. This would address standard and compatibility issues once and for all.. There is no need for the transmitter and receiver to have identical numbers of rows, columns, brightness resolution, colors, and scanning rates. Images may be stored in high resolution and displayed at lower resolution.

***Image quality after compression***

Lossless image compression is theoretically impossible in conventional television, so one must resort to lossy compression, as in MPEG, Wavelets and Fractals. Image quality is then determined by the available bandwidth, which determines the required compression ratios. The more the images are compressed, the worse the image distortion. In contrast wavelet provides essentially “lossless” compression. Every frame is complete and can be frozen or printed out, while video can be displayed in fast forward or according to indexed image searches. Slow motion will not reveal any artifacts or distortions because random noise in the images is interpreted as “movement” any increase in noise increases the transmissions. The cleaner the images and the less noise, the lower the average transmission bandwidth. It is therefore cheaper to transmit high quality images, rather than noisy low quality ones.

Transmission bandwidth in packet switching **networks** Moving images in conventional television was originally designed for fixed bandwidth analog channels, such as the 6.75 MHz. The bandwidth is determined by the hardware parameters, such as image size and scanning rates. Transmitting video via packet switching networks is very difficult and requires expensive high priority channels. But in Slow moving images require few transmissions, while fast action sequences generate more rapid transmissions. Maximum transmission rates are determined by human perception, which allows for only limited complexity and rapidity of movement. Because Autosophy transmissions occur in bursts, packet switching networks are the ideal transmission medium.

**Effects of latency and transmission errors** Errors are almost inevitable in any communication. Satellite transmission errors are introduced, for example, by thunderstorms or solar flares. Internet communication packets are sometimes delayed or dropped due to network congestion. Virtual network packets may be transmitted via different routes and arrive at the receiver with unpredictable delays and in unpredictable order. Re-transmitting defective

Packets are usually not possible. The effect of transmission errors is especially severe in compressed video such as MPEG. Any disruption or error in the data stream causes the image to break up into random noise. In wavelet, only change or movement within the images is selected for transmission. The order in which the super pixel codes arrive at the receiver is irrelevant. Any packet of super pixels arriving during a frame interval usually 1/30 of a second will be included in the next frame scanned from the image buffer to the monitor. There are three options for handling defective packets. If they are re-transmitted during teleconferencing, a small delay in updating a changing spot on the screen may not be visible to the human observer. If defective packets are simply discarded, then a freezing of motion will occur in small spots on the screen. If no error control is used at all, then strange patterns may appear in random spots on the screen. The error effects can be further limited by periodically refreshing the entire image whether or not any change occurs.

**Transmission security, encryption, and privacy** Stereo images with MPEG compressed images on transmissions via satellite or public networks can be secured only with separate encryption hardware or keywords. In wavelet compression with Autosophy television the hyperspace pattern library itself provides a virtually unbreakable encryption option. If the library is kept secret and provided only to authorized receivers, the transmitted super pixel codes represent a virtually unbreakable code. Only receivers in possession of the correct library can decode the transmissions.

## VI. CONCLUSION

In this paper I analyzed about the compression methods which are used to compress the stereoscopic images in non immersive virtual reality world. MPEG is biggest strength may also be its greatest weakness. Even though, the compression method of MPEG is highly efficient, it is very complex in return. Encoding files will requires lot of processor time. Because the need for transmission of such images are in the field of video games and video conferences. As a conclusion of this analysis the wavelet image compression is better than MPEG in the stereoscopic image of non immersive virtual reality world transmission

 

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