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Study of Performance Measurement Factors of Stereo Image Compression

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Abstract: Stereoscopic compression can be achieved by either compression across both views simultaneously, or independently compressing the left and right views separately [Compression algorithms can be divided into two distinct categories. They are either lossless or lossy. Lossless algorithms do not change the content of the file, so if you compress and decompress a file it will not be changed. Lossy algorithms, such as JPEG, are able to achieve a better compression ratio by selectively getting rid of some of the information within the file. Due to the better compression ratio, in this research more interest is shown in lossy algorithms, such as JPEG. The question of how much compression to apply to an stereo image pair before the resulting image becomes noticeably lower from the original is investigated. Most quality models for stereoscopic presentations are dedicated to measuring quality degradation caused by compression artifacts. However, non-compression distortions induced during acquisition and presentation usually have significant influence on 3D viewing experience. . In this paper I wish to illustrate the matrices which are used to measure the stereo image compression quality.

Keywords: Stereo images, Symmetric, asymmetric compression, quality matrices. Human issues.

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I. Introduction

Stereoscopy is a technique for creating or enhancing the illusion of depth in an image by means of stereopsis for binocular vision Most stereoscopic methods present two offset images separately to the left and right eye of the viewer. These two-dimensional images are then combined in the brain to give the perception of 3D depth. This technique is to distinguish from 3D displays that displaying an image in three full dimensions which gives the observer the possibility to increase information about the 3-dimensional objects being displayed by head and movements.

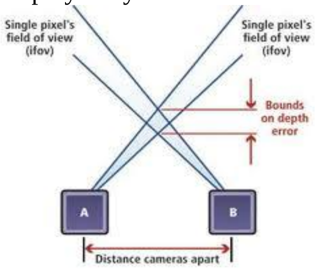

Fig 1. Binocular percept of a stereo image

A stereoscopic image require an increase in storage space compared to monoscopic images, the compression of stereo images is one of the most important factors to enable the extensive use of three-dimensional systems. Substantial research effort has been focused on digital image compression using JPEG Based on theories of binocular suppression, it is often contended that the binocular percept of a stereo image pair is dominated by the high quality component. Thus, when one image of a stereo pair is compressed, such that a high quality is maintained, the other view may be coded more heavily without introducing visible artifacts into the binocular percept.

II. Symmetric and asymmetric encoding of stereo image

Symmetric encoding of the image pair is when the left and right images are compressed by equal amounts resulting in equal degradation. Asymmetric encoding is when the compression and therefore degradation of the left and right images is unequal. Symmetric and asymmetric encoding of compressed images was analyzed using both Peak Signal to Noise Ratio (PSNR) and a subjective human factors study. Photographic, computer generated photo realistic and computer generated non-photo realistic test images are compressed, symmetrically and asymmetrically, using JPEG and, in each case a constant file size was maintained between the pairs.

In symmetric encoding ,First, the left image is independently coded. Then the right image is divided into non-overlapping blocks. Either fixed or variable size blocks are used. Each of these blocks is shifted horizontally and compared to the corresponding blocks in the coded left image using some (MSE, SAD, etc.) measure to determine the similarity between the two blocks. The most similar block, is the disparity compensated prediction, and the corresponding translation is the disparity for the block. Given the right image that is to be encoded and a disparity vector field, there are a variety of coding strategies that may be used. For example, the residual of the disparity compensated prediction may be encoded and transmitted. This method is referred to as Disparity Compensated . residual Coding.

III. Symmetric and asymmetric compression

As stereoscopic images require an increase in the bandwidth compared to monoscopic images, the compression of stereo images is one of the most important factors that must be evaluated to enable the extensive use of three-dimensional systems. The space required to store a stereoscopic image is normally twice the amount need to store a monoscopic one. Similarly, for stereoscopic video, twice the bandwidth is required.

Fig 2. Compressed by symmetric compression

Symmetric compression of a stereoscopic image pair is when the same amount of compression is applied to the left and right image within the pair. If a different amount of compression is applied to each image within the pair, then the stereoscopic image is said to be compressed asymmetrically. In basic terms, asymmetric compression is when a high quality image is presented to one of the eyes and a low quality image to the other.

One method of reducing the storage space or required bandwidth is to compress the images. Existing research shows that both symmetric and asymmetric compression methods are able to significantly reduce the size of the stereoscopic content. However, there is an inconsistency within current research, with different papers suggesting that both symmetric and asymmetric compression methods produce better results. In this section, the existing research is acknowledged and reviewed and conclusions drawn as to the state of current publications.

Fig 3. Compressed by asymmetric compression

MSE is the differences between corresponding pixels of the reference and the distorted images and it can be defined as:

$$MSE = \frac{1}{M*N}\sum_{m=1,n=1}^{M,N} |I(m,n) - I_D(m,n)|^2$$

where M×N is image size. I(m,n) and Id(m, n) represent pixels of reference and distorted images, respectively.

PSNR maps the MSE in a logarithmic way which is defined as:

$$PSNR = 10Log_{10}\frac{MAX_1}{MSE}$$

where MAXI is the maximum value that a pixel can have. As an example, the MAX value for a 8-bit grayscale image is 255. PSNR is a popular and widely used metric to evaluate and quantify performance of image processing algorithms. But it exhibits weak performance in perceived image quality assessment due to pixel-wise error computation. Human vision is sensitive to contrast sensitivity of an image. Therefore, these mathematical models do not always correlate with human perception and fail to predict the perceived quality of an image.

In an alternative approach, each block is either encoded using disparity compensated prediction, or the block is independently coded using an adaptive Discrete Cosine Transform (DCT) The approach used for a given block is determined by the accuracy of the disparity compensated prediction. An alternative technique is to estimate the transform of each right image block, from the transform (DCT) of the matching left image block, using a linear function of the form y=mx+c. Disparity compensation can be implemented using both fixed block size and variable block sizes. Fixed block size schemes have the unique advantage of eliminating the overhead that is required to specify the block locations. However, if multiple objects or an occluded object exist in a block, these schemes cannot fully exploit the stereo redundancy. One solution is to decrease the block size. However, this will increase the overall bit rate for the disparity field, that completely eliminates the necessity of coding the disparity field.

Another approach is to use a segmentation approach. However, not all segmentation techniques are suitable due to the excessive number of bits required to describe the shape and the location of each region.

IV. Human factors in stereo image compression

The majority of the people with good stereovision capability, wide variations are present in depth perception. Thus, in the design and testing of stereo imaging technologies, these effects need to be considered. It has been true ,that with the frequency and duration of use, the stereovision capability of a person may improve, making binocular fusion rapid and more comfortable, thus making the subjective testing of stereo imaging technologies an almost impossible . The viewing distance, screen size, horizontal and vertical parallax, binocular asymmetries, non stop depth cues will all result in the determination of the overall viewing comfort of a stereo scene. As an example, the size distortion of stereo images become noticeable in instances where angular size of a displayed object, and its perceived distance, do not convey as in real world conditions. As a result, smaller displays may contain annoying miniaturization effects. The display sizes of 34" and 50" provide no distortion effects for television like, motion picture display [3]. Unlike under natural viewing conditions, large binocular parallaxes (disparities), tend to produce eye strain. Research has shown that disparities up to 35 monarch, do not cause any noticeable discomfort, irrespective of the spatial resolution of the constituent 2D images [3].

Further, cross talk between the left and right images produces double contours, which is known as ghosting, which in turn would result in headaches. It has also been shown that cross talk increases with the increase of contrast and binocular parallax. The complete removal of cross talk is a practical impossibility. However, for multi view displays having a limited number of views, cross talk could be an advantage. This is due to the fact that it results in the reduction of image flipping, which is essentially the noticeable jump of the image from one perspective to the next. Substantially large number of perspective views would be required to make both flipping and cross talk imperceptible. The success or failure of a stereo imaging system design would largely depend on the visual comfort it provides to the viewer for the long duration viewing of high quality stereo images. Thus, human factors issues will remain an important part in the design of modern and future stereo imaging technologies.

V. Conclusion.

The PSNR results from this investigation showed that in all cases, symmetric encoding, as opposed to asymmetric encoding, produced significantly better results. The human factors study results again suggested that symmetric compression as opposed to asymmetric compression should be used.

It is concluded that in general for stereoscopic image compression, using JPEG, a symmetric as opposed to asymmetric compression approach across the left and right images should be used. The results from the human factors study suggested that in some cases it may be possible to get benefits from applying a small difference in compression between the left and right views. stereoscopic imaging is a technique capable of recoding 3D visual information or creating the illusion of depth. Most 3D compression schemes are developed for stereoscopic images including applying traditional two-dimensional (2D) compression techniques, and considering theories of binocular suppression as well. The compressed stereoscopic content is delivered to customers through communication channels. However, both compression and transmission errors may degrade the quality of stereoscopic images. Subjective quality assessment is the most accurate way to evaluate the quality of visual presentations in either 2D or 3D modality, even though it is time-consuming

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