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Compression of 3D Video Using Huffman Coding

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ABSTRACT

With the recent development of 3D display technologies, there is an increasing demand for realistic 3D video. However, efficient transmission and storage of depth data still presents a challenging task to the research community in these applications. Consequently a new method, called 3D Image Warping Based Depth Video Compression (IW-DVC) is proposed for fast and efficient compression of 3D video by using Huffman coding. The IW-DVC method is to exploit the special properties of the depth data to achieve a high compression ratio which preserves the quality of the captured images. This method combines the egomotion estimation and 3D image warping techniques and includes a lossless coding scheme which is capable of adapting to depth data with a high dynamic range. IWDVC operates in high-speed, suitable for real-time applications, and is able to attain an enhanced motion compensation accuracy compared with the conventional approaches. Also, it removes the existing redundant information between the depth frames to further increase compression efficiency without sacrificing image quality.

Keywords: Depth Map, Motion Compensation, Huffman Coding

I. INTRODUCTION

Compression is performed by a program that uses a formula or algorithm to determine how to shrink the size of the data. Text compression can be as simple as removing all unneeded characters, inserting a single repeat character to indicate a string of repeated characters, and substituting a smaller bit string for a frequently occurring bit string.

Compression can reduce a text file to 50% or a significantly higher percentage of its original size. For data transmission, compression can be performed on the data content or on the entire transmission unit, including header data. When information is sent or received via the Internet, larger files, either singly or with others as part of an archive file, may be transmitted in a .ZIP, gzip or other compressed format.

The main advantages of compression are a reduction in storage hardware, data transmission time and communication bandwidth, and the resulting cost savings. A compressed file requires less storage capacity than an uncompressed file. A compressed file also requires less time for transfer, and it consumes less network bandwidth than an uncompressed file.

Many systems have been designed to minimize the impact of the processor-intensive calculations associated with compression. If the compression runs inline, before the data is written to disk, the system may offload compression to preserve system resources. If data is compressed after it is written to disk, or post process, the compression may run in the background to reduce the performance impact. The post-process compression can reduce the response time for each input/output (I/O), it still consumes memory and processor cycles, and can affect the overall number of I/Os storage system can handle.

Most video codecs also use audio compression techniques in parallel to compress the separate, but combined data streams as one package. The majority of video compression algorithms use lossy compression. Uncompressed video requires a very high data rate. As in all lossy compression, there is a trade-off between video qualities, cost of processing the compression and decompression, and system requirements. Highly compressed video may present visible or distracting artifacts. Some video compression schemes typically operate on square-shaped groups of neighboring pixels, often called macroblocks. These pixel groups or blocks of pixels are compared from one frame to the next, and the video compression codec sends only the differences within those blocks. In areas of video with more motion, the compression must encode more data to keep up with the larger number of pixels that are changing. Commonly during explosions, flames, flocks of animals, and in some panning shots, the high-frequency detail leads to quality decreases or to increases in the variable bitrate. Compression uses modern coding techniques to reduce redundancy in video data. Most video compression algorithms and codecs combine spatial image compression and temporal motion compensation. Video compression is a practical implementation of source coding in information theory. The organization of this paper is as follows. In Section 2 (Related Work) , previous compression techniques and its disadvantages are given. In Section 3 (Proposed Work), I'll give the details of modifications of system using Huffman coding. In Section 4 (Result and Discussion), describes about the obtained result and comparison of various method. In Section 4 (Conclusion) says about the advantage of the system.

II. RELATED WORK

In standard video coding techniques, 2D block matching algorithms are used for motion estimation, in which frames are divided into blocks of M × N pixels, such as 16 × 16 and 8 × 8. A search is performed to find a matching block from a frame i in some other frame j. However, this approach is unfortunately very suboptimal for depth image sequences. Large, homogeneous areas on the surface of an object can be divided into small blocks and the sharp discontinuities at object boundaries can be placed into the same block. Because of this, these schemes result in significant coding artifacts along the depth discontinuities in the reconstructed depth images, especially when the compression ratio is high

The method proposed in [13] exploits the correspondences between the depth images and the corresponding color frames captured by a texture camera. It adopts a conventional block matching approach to determine the MVs according to the texture information. The MVs from the texture information are considered to be encoding both the texture and depth image sequences. The MV sharing algorithm based on the correlation between the motion of the texture and of the depth. This algorithm considers the motion of a block at the same coordinates in both video texture and depth images and uses a joint distortion criterion to generate common MVs for both texture and depth.

An edge-preserving depth-map coding scheme use the texture motion vectors, avoids distortion on edges, and accurately preserves the depth information on edges but it increases the redundancy in the frames. The skipping depth blocks method reduces the bit rate by skipping depth blocks under consideration of temporal and inter-view correlations of texture images. The temporal and inter-view correlations are measured from the temporally successive pictures and the neighboring views synthesized through pixel-by-pixel mapping respectively.

A depth image-based rendering technique is to generate an additional reference depth image for the current viewpoint. The interview correlation is exploited by using a texture and depth view synthesis approach. A block-based depth image interpolation approach was the first and last frames in a texture video are treated as the key frames with known depth images. The remaining depth images corresponding to other texture frames can be recovered by the proposed bidirectional prediction algorithm.

III. PROPOSED WORK

The proposed method first eliminates the redundant depth data at the encoder side. Then the bit stream is further compressed to maximize its storage and transmission efficiency. For the elimination of redundant depth data, instead of using conventional motion compensation algorithms with 2D block-based matching, egomotion estimation and 3D image warping technique is used.

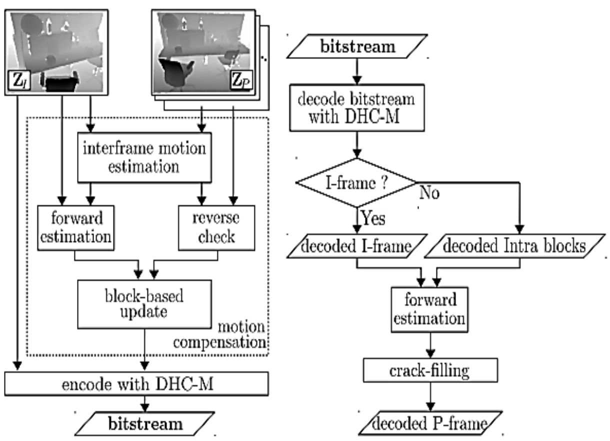
This approach enables better prediction of frames, and so leading to an enhanced compression performance by taking advantage of the characteristic properties of depth images. Then arithmetic code is applied for higher compression. At the decoder side, crack-filling algorithms are adopted to deal with the under-sampling problem in the reconstructed depth images.

3.1 System Model

Let Z_I and Z_P denote an I-frame and P-frame in a group of pictures (GoP) in captured depth video. The system consists of two main components: motion compensation algorithm and a lossless coding scheme. Before encoding Z_P into a bit stream, the differences between Z_P and Z_I should be determined in motion compensation first. The first step of the encoding is the interframe motion estimation.

We estimate the motion of a moving sensor in the time interval of capturing depth frames Z_I and Z_P . In the second step, $\hat{Z}_P$, a prediction of Z_P is generated by using the interframe motion information, forward estimation/reverse check, and block-based update. This procedure estimates the newly observed depth information in Z_P but not in the reference frame ZI. Then, only the newly observed information in ZP is encoded using an entropy coding scheme. As a result, the redundancy in the depth video is taken out during the encoding process.

In the decoding process, the received bit stream is decoded with the same codec used at the encoder side. I-frames can be directly decoded from bit stream. Each P-frame has to be reconstructed using the decoded newly observed information (intra blocks) in each P-frame and its corresponding I frame. Then, a crack-filling approach is used to deal with the under-sampling issue and enhance the quality of the reconstructed P-frames.



(a) *Encoder* (b) *Decoder*

Figure 1. Operational overview of the 3D Image Warping Based Depth Video Compression (IW-DVC) framework.

IV. RESULTS AND DISCUSSION

In this section, we present the comparison performance result of 3D videos for various images using different algorithm.

Table 1. Compression Performance Of JPEG2000, CABAC, AND DHC-M

Dataset		JPEG2000		CABAC		DHC-M	
Archive name	ID	Average Size (KB)	Comp. Ratio	Average Size (KB)	Comp. Ratio	Average Size (KB)	Comp. Ratio
freiburg1_plant	1	72.43	8.48	148.48	4.14	58.42	10.52
freiburg2_dishes	2	68.34	9.00	140.84	4.36	54.91	11.19
freiburg3_cabinet	3	60.02	10.24	118.72	5.18	51.40	11.95
freiburg3_large_cabinet	4	57.47	10.69	105.62	5.82	50.74	12.11
freiburg3_structure_texture_far	5	61.60	9.97	123.91	4.96	52.31	11.75
freiburg3_long_office_household	6	68.51	8.97	107.93	5.69	56.23	10.93
freiburg1_xyz	7	62.74	9.79	127.88	4.80	54.76	11.22

V. CONCLUSION

We have presented a novel coding framework, called 3D image warping based depth video compression (IW-DVC), for efficiently removing the existing redundancy in the depth video. In particular, the motion compensation scheme included in the framework, designed to exploit the unique characteristics of depth images, and works cooperatively with the egomotion estimation and 3D image warping. Experimental results show that our motion compensation method reduces the prediction errors. Also, they demonstrate that IW-DVC framework is capable of keeping the quality of the reconstructed depth image at a high level and can accurately determine the newly observed depth information in each frame. This significantly enhances the compression ratio.

Furthermore, the results show that the IW-DVC framework is capable of operating in real time. As a final note, with the losslessly encoded I-frames, IW-DVC is suitable for many applications that have high requirements on the accuracy of keyframes.

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