Real-Time 2D to 3D Video Conversion using Compressed Video based on Depth-From Motion and Color Segmentation

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Abstract :- This paper provides the conversion of two dimensional (2D) to three dimensional (3D) video. Now-a-days the three dimensional video are becoming more popular, especially at home entertainment. For converting 2D to 3D, the conversion techniques are used so able to deliver the 3D videos efficiently and effectively. In this paper, block matching based depth from motion estimation and color segmentation is used for presenting the video conversion scheme i.e., automatic monoscopic video to stereoscopic 3D.To provide a good region boundary information the color based segmentation is used for fuse with block-based depth map for assigning good depth values in every segmented region and eliminating the staircase effect. The experimental results can achieve 3D stereoscopic video output is relatively high quality manner.

Keywords - Depth from Motion, 3D-TV, Stereo vision, Color Segmentation.

I. INTRODUCTION

3DTV is television that conveys depth perception to the viewer by employing techniques such as stereoscopic display, multiview display, 2D-plus depth, or any other form of 3D display. In 2010, 3DTV is widely regarded as one of the next big things and many well-known TV brands such as Sony and Samsung were released 3D-enabled TV sets using shutter glasses based 3D flat panel display technology. This commercialization of 3DTV [1] is another revolution in the history of television after color TV and high-definition digital TV. Most modern 3D television sets use an active shutter 3D system or a polarized 3D system and some are auto stereoscopic without the need of glass basically, this revolution should be starting from 2005 after Disney's release of 3D version of Chicken Little in movie theatres, the industry rediscovered huge business potential of 3D video content. 3D theatrical releases are now generating more revenue than 2D release. The technologies of 3D displays and digital video processing have reached a technical maturity that possible for making cost effective 3DTV sets. A high quality 3D content may exist generally not directly usable on a home 3DTV.

II. LITERATURE REVIEW

This content were designed to be viewed on a large screen and when viewed on a much smaller screen the left/right pixel disparities become too small that most of the 3D effect is lost. We believe that the conversion of monoscopic 2D videos to stereoscopic 3D videos is one way to alleviate the predicted lack of 3D content in the early stages of 3DTV rollout. If this conversion process can operate economically, and at acceptable quality, it could provide almost unlimited 3D content. Basically, generation of 3D video from monoscopic 2D video input source [2-10] have been investigated for many years. Most of them are based on an estimated depth map of each frame and then using DIBR (Depth Image Based Rendering) [1] to synthesized the additional views. To estimate the depth maps, there are a number of manual techniques that are currently used such as hand drawn object outlines manually associated with an artistically chosen depth value; and semi-automatic outlining with corrections made manually by an operator. Such manual and semiautomatic methods could produces high quality depth maps but they are very time consuming and expensive. As a result, automatic 2D-to-3D video conversion techniques that can achieve acceptable quality are highly interested by both academic and industrial communities. Automatic solution can be easily implemented in a number of hardware platforms, such as notebook PCs and TVs.

A. Evaluation step

In this paper, an automatic scheme is using for block-matching based depth from motion and color segmentation techniques is presented for synthesizing stereoscopic video from monoscopic video. The system structure and design principle will be presented in section II. The depth map generation and DIBR processes are described in sections III and IV, respectively. Experimental results are provided in section IV. Finally, a conclusion is given in section V.

III. SYSTEM STRUCTURE FOR 2D-TO-3D CONVERSION

Stereoscopic video is rely on the illusion effect of the human eye because of small spatial displacement between the right-eye and left-eye views i.e. horizontal disparities, the 3D perception is created in our brain. Thus, the main aim of the 2D-to-3D stereoscopic video conversion system is to generate additional views from monoscopic video input. The basic structure of the proposed automatic 2D-to-3D video conversion system using block-matching based depth from motion estimation [7] and color based region segmentation is shown in Fig. 1.

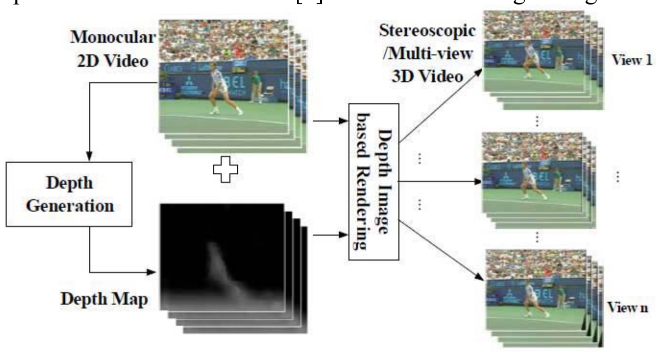


Fig.1 File system structure of the automatic 2D to 3D automatic video conversion.

A. Synthesis View Selection

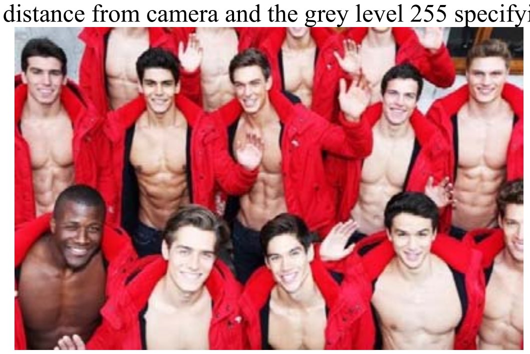
One of the important features of this system structure is that input monoscopic video is used as the output right-eye view video of the synthesized stereoscopic 3D video and the left eye view video is generated based on input video and the estimated depth map by the DIBR. This selection is mainly based on the quality of 3D video and eye dominance characteristic of human perception. To been known that human have a preference of one eye over the other and about 70% are right eye, 20% left eye, and 10% exhibit no eye preference. A recent study [11] found that the role of eye dominance have significant involving on the asymmetric view encoding of stereo views. This result suggest that the right-eye dominant population does not experience poor 3D perception in stereoscopic video with a comparatively low quality left-eye view while right-eye view can provide adequate good quality. On the other hand, the synthesized views of the 2D-to-3D video conversion based on DIBR introduce distortion during the hole-fill process due to the disocclusion problem which lowers the visual quality. Making use of about 70% right-eye dominance population, the proposed system therefore uses the original input video as the right-eye view, generates the left-eye view using DIBR for maintaining high quality right-eye view video.

IV. DEPTH MAP GENERATION

To generate the left-eye view video, which involve two processes: (1) Depth Map Generation and (2) DIBR as shown in Fig.1, the depth map generation process is first introduced in this section.

A. Block-Matching Based Depth Map Estimation

Depth map is an 8-bit grey scale image as shown in Fig. 2(b) for a 2D image frame of Fig. 2(a), with the grey level 0 indicating the furthest distance from camera and the grey level 255 specifying the nearest distance.



a.

(b) (c)

Fig.2 (a) A frame of monoscopic videos,(b) A corresponding true depth map,(c)The grey level of the depth values

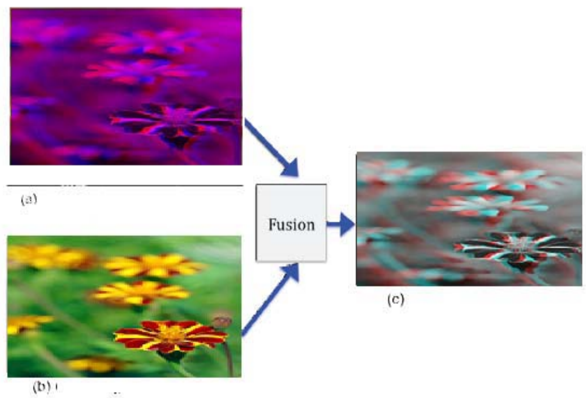


Fig.3 a)Depth map estimated by block matching motion estimation,b) Color segmented Frame,c) Enhanced depth map

To achieve good depth map quality in the proposed system, the depth map of each frame is first estimated by block-matching based motion estimation [7] and then fused with color based region segmented image. The basic principle is motion parallax, near objects move faster than far objects, and thus relative motion can be used to estimate the depth map. Fig. 2: (a) A frame of a monoscopic video, (b) the corresponding true depth map, (c) the grey-level of the depth values. Fig.3: Depth map enhancement by fusion with color segmented image. The main way to implement this principle is to divide the 2D image frame into non-overlapping 4x4 blocks to do block-matching based motion estimation use the previous frame as reference. The depth value D(i,j) is estimated by the magnitude of the motion vectors as follows:

$$D(i,j) = C\sqrt{MV(i,j)_x^2 + MV(i,j)_y^2}$$

Where MV(i j)x and MV(i,j)y are the horizontal and vertical components of the motion vectors and C is a pre-defined constant. The drawback of this method is the computational requirement is very high if full-search method is used in motion estimation. To overcome this problem, fast motion estimation algorithm of cross-diamond search is used in the proposed system, which can achieve the similar depth map estimation accuracy while significantly reduce the computational requirement.

A. Color Segmentation

The drawback of the block-based depth estimation method is generated motion fields often suffer from serious staircase effect on the boundary of the region or object as shown in Fig. 3(a). To get best depth map, sophisticated region border correction technique is needed. In the proposed system, color based region segmentation is used because it can provide consequence information of different regions that is the block-based motion depth map lacking of. To eliminate blocking effect as well as reducing the noise, fusion with block-based depth map and color segmented image is used. The adopted color segmentation involves two processes:

1) Dominance colors generation by CQ and

2) Regions segmentation by requantization. Agglomerative clustering with reducing quantization level is used for color quantization (CQ) which providing good trade off on quality and computational efficiency. Based on this method, continue region with similar colors can be segmented. An example of segmented frame is shown in Fig. 3(b), that shows very smooth boundaries in difference regions and which is very effective for enhancing the blocky depth map.

C. Fusion

To enhance the block-based depth map as shown in the Fig. 3(a), merge it with the color segmented image as shown in Fig. 3(b). In this paper this process is called fusion. The motive of the fusion is to eliminate the staircase effort of the block-based depth map by using the good boundary information from the color segmented image. In addition, this fusion can also help on assigning best depth values in every region by using the average of the depth values within the same region. The fusion with average considerate the depth of whole part of the specify segmentation area takes average of the depth value from the motion estimation depth map. In the area of corresponding segmentation is assigned the value to the enhanced depth map. This process has a better estimation of the depth when there exist part of area with small or large depth value. The enhanced depth map is shown in Fig. 3(c).

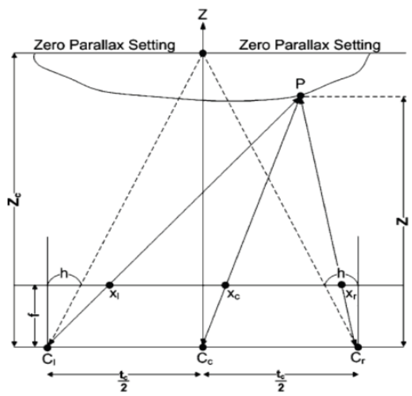


Fig 4 Camera configuration for configuration of virtual stereoscopic images

V. DEPTH IMAGE BASED RENDERING (DIBR)

The stereoscopic 3D video is generate by using DBIR, DIBR is used to synthesis the left-eye view video based on the estimated depth map and monoscopic video input as shown in Fig. 1. The DIBR algorithm consists of two processes: (1) 3D Image Warping and (2) Hole-filling.

Hole-Filling:

There are two major problems for the synthesized image by 3D image warping, which are called occlusion and disocclusion. The two different pixels of the real view image are warped to the same location in the virtual view is called occlusion. This problem is not difficult to resolve as it can use the pixels with larger depth values (closer to the camera) to generate the virtual view. The occluded area in the real view may become visible in the virtual view is called disocclusion. The disocclusion problem, however, is difficult to resolve because there is no information provided to generate these pixels. Thus, a hole-filling process is required in DIBR to fill out the area lacking of data. In the proposed system linear interpolation is adopted but it will introduce stripe distortion. To minimize the effect of stripe distortion on the generated stereoscopic video's depth perception for right-eye dominance population, the proposed system uses the input video as the right-eye view and only the left-eye view is synthesized with such distortion.

ALGORITHM

The algorithm to minimize the above objective proceeds in two phases. In phase one, while{t.A} are held fixed, m is initialized with soft max function, described below, and then iteratively projected across its rows and columns until the procedure converges. In phase two{ t, A} are updated using coordinate descent. Then β is increased and the loop repeats. Let E2D to be the objective without the terms that enforce the constraints(i.e. the z log z barrier function and the lagrange parameters) In phase one m is updated with soft max:

$$m_{jk} = \frac{\exp(-\beta \frac{\partial \hat{E}_{2D}}{\partial m_{jk}})}{\sum_{k'=1}^{K+1} \exp(-\beta \frac{\partial \hat{E}_{2D}}{\partial m_{jk'}})}$$

Then m is iteratively normalized across j and k until

$$\sum_{j=1}^{J} \sum_{k=1}^{K} \Delta m_{iajk} < \epsilon \ :$$

$$m_{jk} = \frac{m_{jk}}{\sum_{j'=1}^{J+1} m_{j'k}} \quad ;$$

$$m_{jk} = \frac{m_{jk}}{\sum_{k'=1}^{K+1} m_{jk'}}$$

Using coordinate descent the {t,A} are updated in phase two. If a term of{A} cannot be computed analytically (the terms are regularized) , Newton's method is used to compare the root of root of the function. So if α is a term of {t,A} then in phase two we update α a such that θ E2D / θ α = 0 finally β is increased and the loop repeats.

By setting the partial derivations of E2D to zero and initializing the lagrange parameters to zero, the algorithm for phase one may be derived. Beginning with a small β allows minimization over a fuzzy correspondence matrix m, for which a global minimum is easier to find. Raising β drives the m's closer to 0 or 1, as the algorithm approaches a saddle point.

Algorithm:

Input : set of probe functions a = {c(i, j), o(i, j)}
Output: ranking of all segment pairs sij
For (all segments si
In the first image) do
For (k=2 to (# of segments in the second image)/2) do
Perform k-means clustering for each probe function separately
For (each subset b of the set of all probe functions f) do
Find b∗
(z)
For (each segment sj
From the second image) do
If (sj
∈ b∗
(z)) then
Vote for pair sij
End
End
End
End
End

Experimental results

In this section we detail the strength and applicability of our algorithms. We provide experimental results for both the 2D and 3D matching problems. As an application of the 2D matching algorithm we present results in the context of hand written character recognition.

TOOLS

Axara Video Converter [13] is the comprehensive and stable video file converter program. Convert video, DVD & audio between more than 30 media formats, including HD. All the popular formats are supported: Avi, MKV, Flash, FLV, F4V, MPEG, MP4, M4V (iPhone/IPod/Mobile/PSP/Zune), MTV, MKV, ASF, VOB, VRO, AMV, MSV, 3GP, MOV, RM and many others. You can create and burn your DVD-Video onto a CD for the further watching on a home DVD-Player. Using Burner you can quickly and easily burn any of your movies onto CD/DVD/BD discs in any mode, as a DVD-Video or as a Data-Video (DivX, AVI). Also you can Rip, Copy personally authored DVD or movies which are not encrypted into AVI (DivX, H.264), M4V, WMV.

By means of Video Editor you can: Edit video movie; Delete fragments; Split the file into some parts by markers; save an audio track from the movie and many other functions. Using Internet Video Downloader tool you are lucky to download to offline and convert internet video from any sites, namely: YouTube, Google Video, Yahoo Video, and MySpace Video.

VI. CONCLUSION

This paper presents a robust 2D-to-3D stereoscopic video conversion system for off-line automatic conversion application. To make use of the right-eye dominance population and reduce the impact of the stripe distortion introduced in hole-fill of the DIBR, the left-eye view is generated by block-matching based depth from motion estimation with color segmentation enhancement and the input video is used as the right-eye view of the output stereoscopic video. The experimental results show that the proposed conversion scheme can produce satisfactory results.

VII. EXPERIMENTAL RESULTS

The proposed 2D-to-3D stereoscopic video conversion scheme is implemented on the MS-Windows platform for off-line automatic conversion. To evaluate the quality of the generated stereoscopic 3D videos several test sequences are used. The subjective evaluation was performed that the 3D perception of the generated video is relatively good especially for video with a lot of object motions. Fig. 3 shows one of the test video sequences for basketball in anaglyph format, which achieve very good 3D video quality in terms of senses of stereo, reality, and comfort ability. However, the major drawback of this scheme is that the computational requirement is very high and is not suitable for real-time applications.

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