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Development of 3D Stereoscopic Image Generation System Using Real-time Preview Function in 3D Modeling Tools

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ABSTRACT

A 3D stereoscopic image is generated by interdigitating every scene with video editing tools that are rendered by two cameras' views in 3D modeling tools, like Autodesk MAX® and Autodesk MAYA®. However, the depth of object from a static scene and the continuous stereo effect in the view of transformation, are not represented in a natural method. This is because after choosing the settings of arbitrary angle of convergence and the distance between the modeling and those two cameras, the user needs to render the view from both cameras. So, the user needs a process of controlling the camera's interval and rendering repetitively, which takes too much time. Therefore, in this paper, we will propose the 3D stereoscopic image editing system for solving such problems as well as exposing the system's inherent limitations. We can generate the view of two cameras and can confirm the stereo effect in real-time on 3D modeling tools. Then, we can intuitively determine immersion of 3D stereoscopic image in real-time, by using the 3D stereoscopic image preview function.

Key words: 3D stereoscopic image, Autodesk MAYA®, MEL Script, Preview function

1. INTRODUCTION

Recently, because of development of the film and movie industry related to 3D TV broadcasting that offer 3D stereoscopic contents, these technologies have shown increasingly many developments and interest for editing and obtaining animation of high quality. Currently, real stereoscopic image is photographed using two general cameras in real stereoscopic image production [1]. With the cameras in place, we can manipulate positive parallax with confirming angle and distance of two cameras through two view finders by turns. However, due to the use of a photographing mount of an automated stereoscopic image, we can manipulate the distance of the two cameras easily. Moreover, conversion methods [2-7] from a 2D photographed image to a 3D stereoscopic image are being researched and 3D stereoscopic editing tools are sold for commercial products [8,9]. However, animation production made much use of Autodesk Maya® and Autodesk MAX® [10], which offered powerful functions. Generally, when we generate 3D stereoscopic images in 3D modeling tools, we use two virtual cameras. After the distance between the two cameras is manipulated, then every scene can be generated by rendering both cameras' views. The next step is the final 3D stereoscopic image that is generated by rendering all images provided by the

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camera, through the interdigitation process, by using the movie editing tools. Recent methods [11-14] using these basic methods have been developed into Plug-in and Script forms of Autodesk MAX® or Autodesk MAYA®. However, because 3D stereo degree is different from user to user, stereo degree of the 3D stereoscopic image must be generated by constantly manipulating and rendering. In order words, the interval of the left and right camera, the distance between modeling information and the camera, and the angle between the left and right camera must not be controlled. In addition, when generating the image, for which the stereo effect is high, control of the camera interval and rendering of both eyes must be done repetitively.

In this paper, we overcome some of these limitations and propose a new method aimed to generate 3D stereoscopic images which are able to allow audiences to feel natural stereo degree and more immersion. Therefore, we manipulate stereo degree in real-time and can improve immersion for the easy generation of 3D stereoscopic images using existing modeling information. Furthermore, we have developed a stereo camera generation module and real-time preview module for being able to confirm stereo degree of 3D stereoscopic images on a 3D stereo monitor. Therefore each module is designed as a MEL (Maya Embedded Language) form of Autodesk MAYA®. MEL belongs to a scripting language with one of the tools for offering the powerful open structure in Autodesk MAYA®. It makes us for indirectly and directly controlling function of Autodesk MAYA® in a low-level. Therefore, if anything works, we can increase its efficiency, development and specific function.

This paper is organized as follows: In section 2, we describe previous work for generating a 3D stereoscopic image in 3D modeling tools. In section 3, we illustrate an overview of our system. Section 4 explains the interactive 3D stereoscopic image editing system which is proposed in this paper. Section 5 provides a discussion of experimental results using our system. Conclusions can be found in Section 6.

2. PREVIOUS WORK

The 3D modeling tools Autodesk Maya® and Autodesk MAX® only represent basic objects using coordinate information on a 2D plane. Therefore, it is difficult for generating complete 3D stereoscopic images. When 3D stereoscopic images are generated with 3D modeling tools, we create a stereo camera on modeling information at a 65mm interval and render the left and right camera views. Finally, we generated 3D stereoscopic images through an interdigitation process by using movie editing tools. However, because the arrangement and parallax of each rendering image is not correct in general methods, it caused problems so that the 3D stereo effect was hardly felt.

Recently, DepthCAM[11] and XidMary[12] which is developed in Autodesk MAX® Plug-in forms, could generate the a 3D stereoscopic image. DepthCAM (Fig. 1) for use with Autodesk MAX® 8.0 and v7.x enables you to create 3D stereoscopic images by providing stereoscopic cameras and other multiplexing support. DepthCAM adjusts camera separation dynamically, based upon your target screen size, or you can take control and set everything manually. DepthCAM can take the

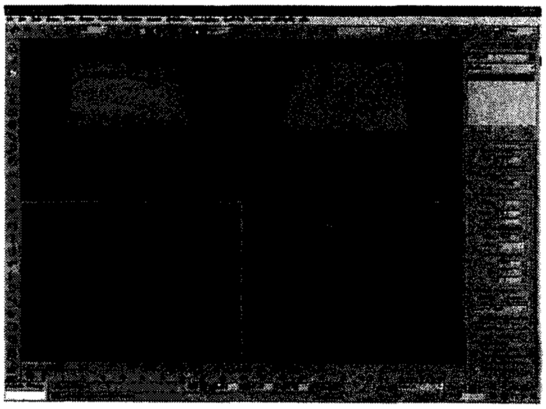


Fig. 1. VREX's DepthCAM.

same animation or stills and output into different stereoscopic formats including anaglyph, interleaved(row or column), over-under, or side-by-side stereo formats. DepthCAM creates perfect 3D on all edges of an image while similar products cause a distorted 3D effect in corners.

Simulating two-eyes by its default Xid-cameras (Fig. 2) is quick and easy. You don't have to merge the stereoscopic images manually anymore. XidMary will do everything automatically. You can even watch the stereoscopic images directly with your shutter glasses.

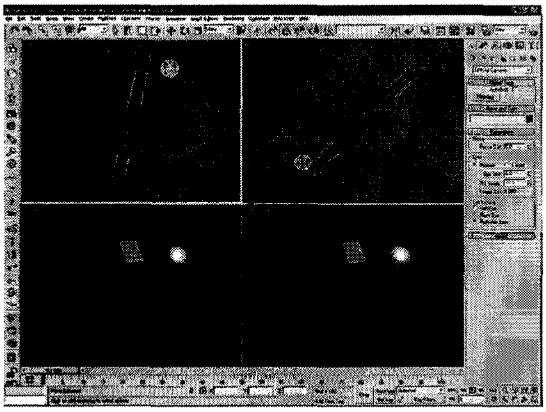


Fig. 2. HABWare's XidMary.

SVI MaxPlug-in and MayaPlug-in which has been developed by SPATIAL VIEW [13], provides before rendering a preview function, but it is only possible for the confirmation of one scene(Fig. 3). With SVI Max Plug-in 2.0, it's now possible to output single image elements like Shadow, Reflection, Opacity, or Z-Depth-Pass, in stereo. The post processing of created materials can then, as usual, be done with any post-production tool available. For the creation of the final stereo-image, simply use the utility integrated into SVI MaxPlug-in 2.0. With a fast rough-preview of the shaded or wire frame models at hand, selected camera parameters can be quickly and easily assessed so corrections can be made prior to rendering the final version.

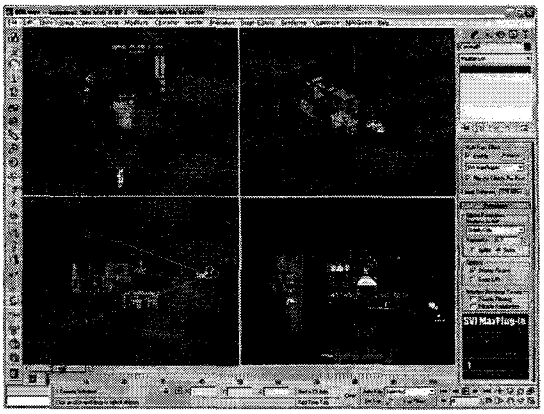


Fig. 3. SPATIAL VIEW's SVI MaxPlug-in.

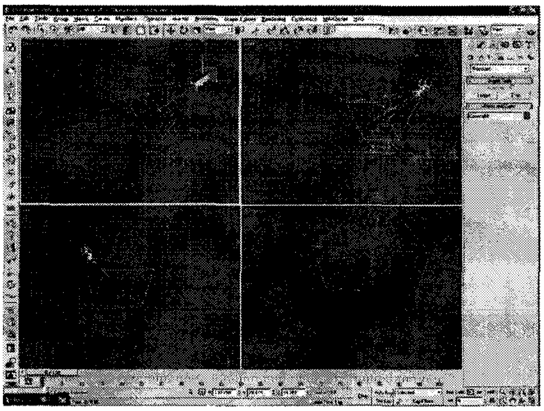


Fig. 4. RKL's Stereographer Max.

A simple setup enables you to output the scenes in any stereo format and onto any 3D display. Reference planes for the description of the scene's size give you exact control over depth perception and position of the objects in space. The SVI MayaPlug-in integrates seamlessly into the normal workflow of Autodesk Maya®. Existing scenes can be prepared for stereoscopic output easily and without any prior knowledge. All important parameters affecting 3D can be visualized, and the corresponding reference planes adjusted for total control of the stereo effect. Problems like too little or exaggerated depth are easily spotted, and easy to avoid, keeping the final work easy on the eyes. Stereographer Max [14], which has been recently developed in Autodesk MAX® Script, generates 3D stereoscopic images easily because the camera creation and rendering is possible with a simple interface(Fig. 4).

The methods of existing, which are developed into Plug-in or Script forms, have many critical points. In order words, because 3D stereo degree is different from every user, when the camera of both eyes is created, the user can confirm the 3D stereoscopic image, only after the render. When generating the image, for which the stereo effect is high, control of the camera interval and rendering of the both eyes must be repetitively accomplished. The common flowchart of existing methods has been explained in Fig. 5. The function that will be able to confirm the 3D stereoscopic images in real-time, is not provided by existing methods. Therefore, when a 3D stereoscopic image is generated, a lot of time and effort is required.

3. SYSTEM OVERVIEW

A flowchart describing the proposed 3D stereoscopic image editing system is illustrated in Fig. 6. The flowchart of our system is simple, since it only consists of a set of three parts. First, the processing is the creation of a 3D stereo camera within a 3D modeling information. Second processing is controlling the stereo camera interval and zero crossing point. This processing determines the stereo camera disparity using an interactive preview function through the stereo monitor intuitively and in real-time. We show that this processing provides the user with long viewing of high quality stereoscopic imaging. Finally, we generate 3D stereoscopic images after rendering the processing of each camera view.

4. REAL-TIME STEREOSCOPIC IMAGE GENERATION SYSTEM

4.1 Stereo Camera Generation

There are three methods for generating 3D stereoscopic images. In this paper, we have developed

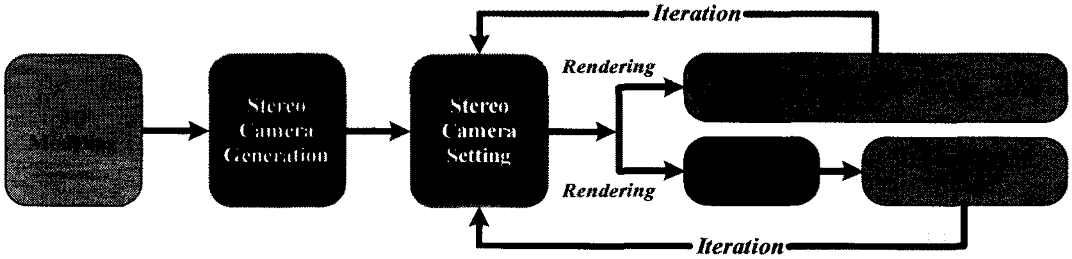


Fig. 5. Common flowchart of existing methods.

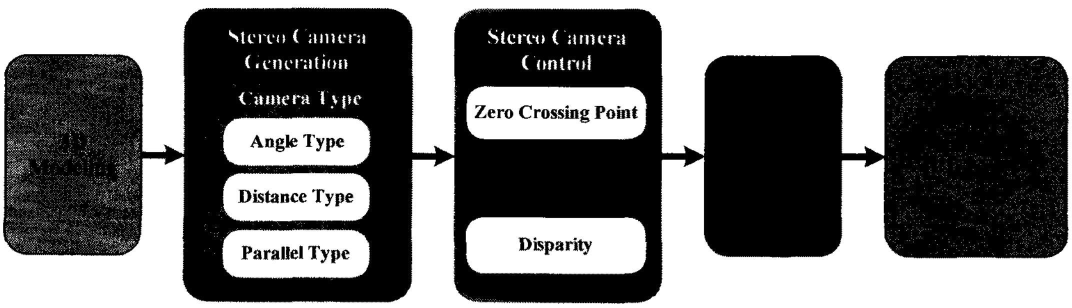


Fig. 6. Flowchart of the proposed system.

Autodesk Maya® Plug-in of stereo camera generation based on these three methods in 3D modeling tools, which are explained in Fig. 7.

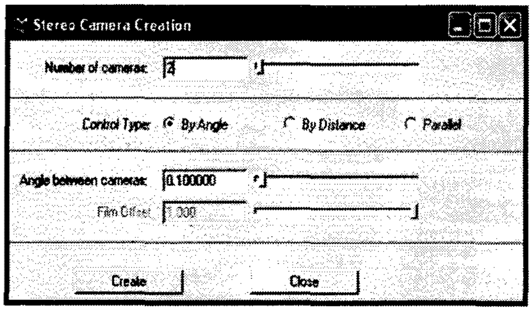


Fig. 7. Stereo camera generation Interface in Autodesk Maya®.

Our three methods of stereo camera generation are illustrated in Fig. 8. First, the method of controlling angle with modeling object based on two cameras' central axis is shown in Fig. 8(a). Second, crossing the stereo camera method similar to the eyes is shown in Fig. 8(b). This is a method of offering high stereo effect when controlling distance between two cameras' central axes. Third, Fig. 8(c) shows the method of setting the distance in two parallel cameras. Fig. 8 shows three types of stereo cameras for setting a stereo camera.

(a) Angle type (b) Distance type (c) Parallel type

Fig. 8. Stereo camera types.

After generating the stereo camera at 3D modeling information in Autodesk Maya®, we work on the top view (Fig. 9(a)), perspective view (Fig. 9(b)), left camera view (Fig. 9(c)), and right camera view (Fig. 9(d)). The work layout of Autodesk Maya® is shown in Fig. 9 for modeling object.

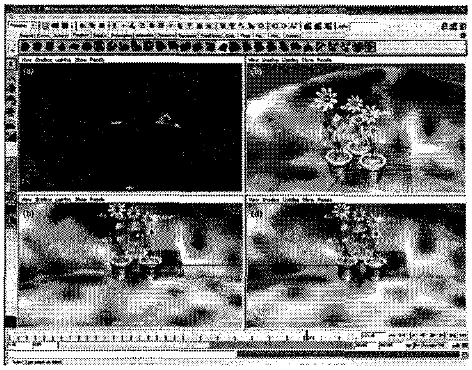
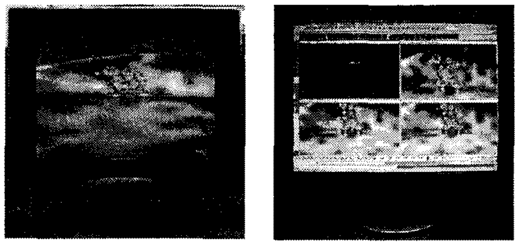


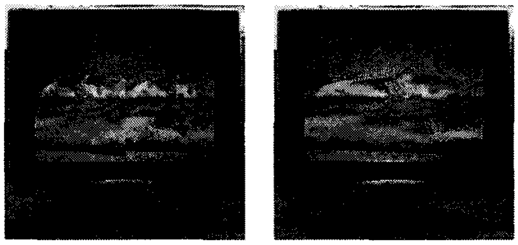
Fig. 9. Autodesk Maya® layout.

A left and right view is able to show stereoscopic view though a stereo monitor using polarizing glasses in real-time. Then we can generate the best stereo scene and animation. Fig. 10(a) shows left and right camera view in Autodesk Maya® through stereo monitor. Fig. 10(b) shows the operation view in Autodesk Maya® through general LCD monitor.



(a) Stereo monitor view (b) 3D modeling view

Fig. 10. Interactive stereo camera system.



(a) Left, right camera view (b) 3D stereoscopic view

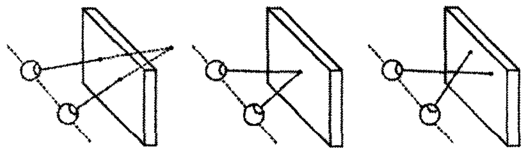
Fig. 11. Images interdigitation in 3D stereo monitor.

Fig. 11 shows that left and right camera view is interdigitated. Some types of stereo monitor interdigitation are: interlaced stereo type, sidefields type, subfields type and frame sequential type. In this paper, we experimented on sidefields type.

4.2 Interactive Preview

Stereoscopic imaging is generally viewed naturally from a comfortable distance with binocular vision displayed so that the right-eye and left-eye images are directed to the appropriate eyes. Disparity and zero crossing point are important stereo vision cues in stereoscopic imaging generation.

If the object is processed with negative parallax (Fig. 12(a)) in order for it to appear closer than the plane of the screen, the screen surround problem will occur. It is a conflict of depth due to the interposition factor that the object must be behind the window. It processes both the object and the background with positive parallax (Fig. 12(c)) in order to solve this problem. That is, it processes so that the object is behind the plane of the screen and the background is behind the object.



(a) Negative type (b) Zero type (c) Positive type

Fig. 12. Parallax types.

Therefore, disparity (parallax) and zero crossing point are important stereo vision cues. The 3D stereoscopic animation scene is generated by manipulating the disparity and zero crossing point. However, it is hard to determine the exact disparity and zero crossing point. Unfortunately, people's stereo vision capability, disparity, and zero crossing point are different. The alternative of improving stereovision capability by using images taken from disparity and zero crossing point has the disadvantage that computing depth becomes very sensitive to noise in image measurements. Generally, after manipulating disparity and zero crossing point, it is much more difficult to generate a stereoscopic image. In order to solve this problem, we have proposed an interactive stereoscopic image preview system that makes it possible to intuitively and in real-time determine the disparity and zero crossing point from left and right camera view. The success or failure of a stereoscopic imaging system design would largely depend on the visual comfort it provides to the viewer for the duration of viewing high quality stereoscopic images. Thus, disparity and zero crossing point are important stereo vision cues in stereoscopic imaging generation. This process relates to real-time verified stereoscopic imaging using stereo monitor and polarizing filter glasses.

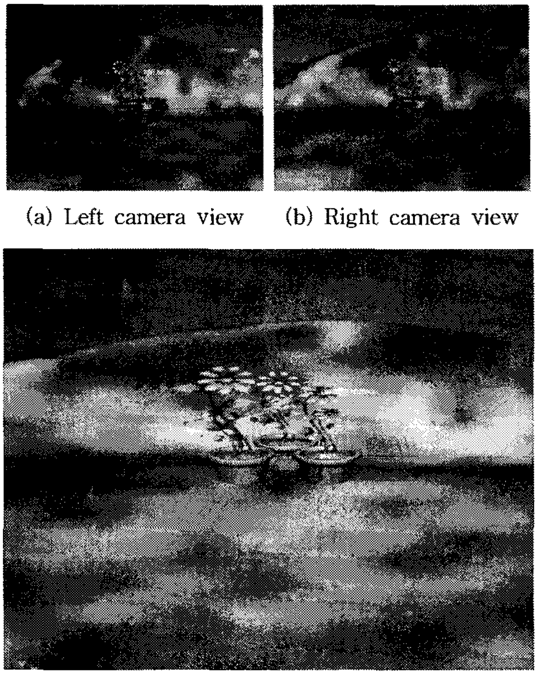
This real-time preview module consists of two methods. The first method is full 3D stereo view and the second method is part 3D stereo view. In the case of using a dual monitor, we control full 3D stereo view through stereo monitor and manipulate the camera interval and zero crossing point through a general 2D monitor. So, we can confirm and edit the stereo degree of the 3D stereoscopic image easily. Then it is possible to confirm 3D stereo view by presenting full view using Form Layout in MEL. Form Layout is one in the most powerful layouts which is provided by MEL. Form Layout allows absolute and relative positioning of the controls. In the case of using the stereo monitor, we intuitively and in real-time determine from disparity and zero crossing point by using through part 3D stereo view module. The efficient work is possible because interdigitation is done in only a specific part of the work module. Then the stereo monitor is set up in DDC communication with usual SCA, SDA clock and two channel of accomplishing with data. In order to interdigitate part 3D stereo view, after changing the registry data in the FPGA setting, the data is represented in the monitor screen using the scaler.

We can generate the final 3D stereoscopic images after determining the high 3D stereo degree. Since we don't want to encounter any problems in the process, we make sure only the view that we currently want to render is renderable. When we finish the left camera view's rendering, we make sure it is not renderable and that right camera view is renderable. Next make right camera view renderable, left camera view unrenderable, and repeat the previous step, changing the filename prefix to something like "right-Camera", and make sure that the right camera view is the camera selected in the Render Globals Common window. We have a quality sequence of stereo image pairs, ready to be made into any kind of animation. We use the transformation position option for each image to position the left image sequence exactly at the left of the composition and the right image exactly at the right. Finally the 3D stereoscopic image is generated through an interdigitation process by using movie editing tools.

Fig. 13. An experimental demonstration.

We manipulate the camera interval and zero crossing point through general LCD monitor and control the full 3D stereo view through the stereo monitor with polarizing filter glasses in real-time. So we can confirm and edit the stereo degree of the 3D stereoscopic image easily. The experimental demonstration is shown in Fig. 13.

5. IMPLEMENTATION AND RESULT



(a) Left camera view (b) Right camera view

(c) 3D stereoscopic image

Fig. 14. Generation of 3D stereoscopic view.

Our system has been developed on Pentium 4.3GHz, 1GB RAM using the Autodesk Maya® based MEL Script and implemented on Autodesk Maya® 7.0. The final resulting images can then be displayed on a stereo monitor made by the Pavonine [15], allowing all of the original views to be projected, producing a stereo effect when viewed by an observer using polarizing filter glasses. Content for the stereo monitor of the Pavonine is created by applying an interdigitation process (called Interzigging) to generate of stereo image. The interdigitation process interdigitates the left camera view and right camera view.

The stereo monitor of made by Pavonine is a stereoscopic viewing monitor that requires additional processing to be done for creating a suitable viewing stereoscopic image. The example of generation of 3D stereoscopic view is explained in Fig. 14.

6. CONCLUSIONS

In this paper, we have presented a technique to make real-time 3D stereoscopic images using originally created modeling information with human visual features to create and control a stereoscopic camera. Therefore, we have provided the generation of stereo camera and 3D stereoscopic image preview function which is the critical point when generating 3D stereoscopic images in existing 3D modeling tools. Furthermore, we have developed MEL forms of Autodesk Maya® for more general-purposes and scalability. We have also provided stereo degree in existing one scene as well as sequence scene imaging, such as animation. These developments have raised the system's overall effectiveness by creating a real-time stereo degree through a stereo monitor--since most people's stereo vision capability, disparity, and zero crossing point can differ greatly.

REFERENCES

[1] 3DnShop, "http://www.3dnshop.com".

[2] S. Battiato, A. Capra, S. Curti, and M. La Cascia, "3D Stereoscopic Image Pairs by Depth-Map Generation," *Proceedings of the 2nd International Symposium on 3D Data Processing, Visualization, and Transmission (3DPVT'04)*, pp. 124-131, 2004.

[3] C.H. Choi, B.H Kwon, and M.R. Choi, "A Real-Time Field-Sequential Stereoscopic Image Converter," *IEEE Trans. on Consumer Electronics*, Vol.50, pp. 903-910, 2004.

[4] P. V. Harman, J. Flack, S. Fox, and M. Dowley, "Rapid 2D to 3D Conversion," *Proceedings of SPIE Stereoscopic Displays and Applications '02*, Vol.4660, pp. 78-86, 2002.

[5] T. Okino, H. Murata, K. Taima, T. Iinuma, and K. Oketani, "New Television with 2D/3D Image Conversion Technologies," *SPIE Photonic West*, Vol.2653, pp. 96-103, 1995.

[6] L. Zhang, W. J. Tam, and D. Wang, "Stereoscopic Image Generation Based On Depth Images," *International Conference on Image Processing*, Vol.5, pp. 2993-2996, 2004.

[7] L. Zhang and W. J. Tam, "Stereoscopic Image Generation Based On Depth Images for 3D TV," *IEEE transactions on broadcasting*, Vol.51, No.2, pp. 191-199, 2005.

[8] DDD, Tridef Website, "http://www.ddd.com".

[9] TGS Website, "http://www.tgs.com".

[10] Autodesk, "http://www.autodesk.com".

[11] DepthCAM, "http://www.vrex.com".

[12] XidMary, "http://www.habware.at/ente.htm".

[13] SVI MaxPlug-in, "http://www.spatialview.com".

[14] Stereographer Max, "http://www.burningpixel.com".

[15] Pavonine, "http://www.3dview.co.kr".

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