BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LXVII No. 3/2015	31 – 36	Seria Tehnică

Basic Problems Involved by Generating Tridimensional Multimedia Content

Cosmina-Mihaela Roșca, Gabriel Rădulescu

Universitatea Petrol – Gaze din Ploieşti, Bd. Bucureşti 39, 100680, Ploiesti
e-mail: cosmina.rosca@upg-ploiesti.ro, gabriel.radulescu@upg-ploiesti.ro

Abstract

This article presents anaglyph method for generating tridimensional multimedia content. We will discuss how to acquire 2D image and how to convert 2D images to 3D image by keeping the original image accuracy. In this paper we show some problems regarding the 3D effect construction. This article proposes an algorithm to solve those issues. The algorithm was implemented by using Matlab environment and the results highlight its effectiveness in generating 3D images.

Key words: *stereoscopic 3D, three-dimensional images, depth, 2D to 3D converter.*

Introduction

Recent research shows new applications using tridimensional (3D) technology in 3D mapping, biology, 3D printers, medicine, network security, virtual reality, movies industry and many more areas [1][2]. Stereoscopy is a process based on two cameras or one device with two objectives. In this way, the device acquires images from slightly different angles. The stereoscopy processes these images so that each eye receives the corresponding channel image.

There are many techniques for generating and rendering 3D multimedia content such as anaglyph method, polarized projection, double-shutter etc., but all these methods has to produce the same characteristic: the depth [3]. The 3D images are 2D images processed using filters with the objective to obtain the depth effect. In order to get the spatial factor, we have to take care about the gap between left image and right image, the angle between camera and object, vertical positioning of objects within the image, interposition of objects in the image, colors, shadows and lights into the image. The human brain will recompose three-dimensional image based on these processed ones, and considering the factors listed above. Because of their applications, 2D to 3D conversion algorithms has been widely studied and various applications were developed based on the same idea.

First section will present the anaglyph technique and we will compare this method with polarized method. The second section will explain the basic algorithm for converting 2D images to 3D images. Finally, we will present our application developed for generating an accurate 3D image using 2D images. Experimental results will demonstrate the algorithm efficiency.

Anaglyph Method

This technique involves a red channel image that overlaps with a blue channel image. The resulted anaglyph image can be viewed using specially designed glasses, red/cyan or red/blue [4]. The resulting image will be seen by each eye as follows: the red area of the image will be sent to the red lens as a white area, the blue area of the image will be sent to the blue lens as a black area. In figure 1 one can see how each eye perceives differently filtered image of red lens or blue lens. The brain processes the two images (the red image and the blue image). The resulting image is a three dimensional image characterized by the depth of field generated by differences between the red filter image and the blue filter image. The main problem of this method is the colormap changes, being generated by the filtering process. As consequence, the original image will be blurred. When the original image quality is low, three-dimensional image can no longer be distinguished objects. For this reason, 3D image process requires automatic fusion approach [5]. The great advantage of this technique is the easiest way to process the 2D images in order to obtain the 3D image and the reduced costs for acquisition anaglyph glasses, which are made mostly of cardboard and plastic lenses in red and blue.

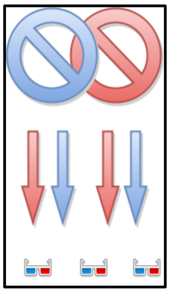

Fig. 1. Blue image for the left eye and red image for the right eye

Polarization is another method of displaying three dimensional multimedia content. Polarized images can be seen only with polarized glasses. These lenses are polarized filters, which can be linearly polarized glasses or circularly polarized glasses. Projection screen must preserve the polarization for each eye to receive the corresponding image. This screen is specially designed, with vertical stripes of reflective materials and it is called "silver screen". Comparing with the anaglyph technique, for the polarized method the image colors are not modified. However, due to vertical or horizontal polarization for each image, only half of the pixels will be seen, so the image quality will be affected.

Next, we will focus on anaglyph method because of the reduced producing costs. Three-dimensional images are obtained by superposition of two 2D images. The two images are slowly displaced, the first has a red filter and the second has a blue filter. The two images are acquired from different angles. More details about calibration for stereoscopic technique in [6]. When the distance increases, the angle increases too.

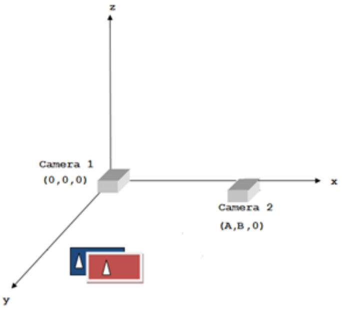

Fig. 2. Calculates the distances for acquisition

We assume that the first camera is located at the point (0,0,0) and the second camera at the point (A, B, 0), as shown in figure 2. The focused object is located at the point P of coordinates (x1, y1, z1). It is also assumed that the image 1 (the image acquired by the camera 1) is in the position $[r_1, s_1]$, and the image 2 in the position $[r_2, s_2]$. Using central projection equation, where F is the focal length we can obtain:

$$z_1 = r_1 \frac{z_3}{F} = A + r_2 \frac{z_3}{F};$$

$$z_2 = s_1 \frac{z_3}{F} = B + s_2 \frac{z_3}{F};$$

Since both cameras have the same focal length, $z_3 = F \frac{A}{r_1 - r_2} = F \frac{B}{s_1 - s_2}$.

For example, if the two cameras are located at the points (0,0,0) and (6,6,0), and the subject is in the position [200, 10] and [190, 0] and focal length is of 2.8, then the object coordinates are:

$$z_3 = 2.8 \frac{6}{200-190} = 2.8 \frac{6}{10-0} = 1.68;$$

$$z_1 = 200 \frac{1.68}{2.8} = 6 + 190 \frac{1.68}{2.8} = 120;$$

$$z_2 = 10 \frac{1.68}{2.8} = 6 + 0 \frac{1.68}{2.8} = 6.$$

The image produced in this way is a blurred image with a large gap between the two channels and without the effect of depth zones. We can make the offset correction only software, using a shifting parameter. As a result, we will shift the red frame or the blue frame keeping the same position for the other.

The second problem is the area without depth effect generated by the different angle for images acquisition as it can be seen in figure 3.

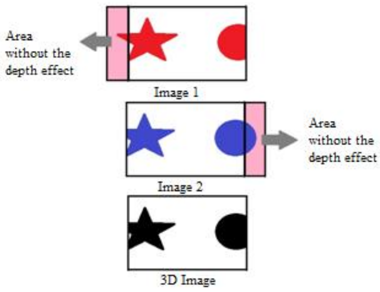

Fig. 3. Areas without 3D effect.

In the next section we will propose a new method that can solve these issues. Another projection method is described in paper [7] and it provides a new way "to generate anaglyph stereoscopic images using the spectral absorption curves of the glasses, the spectral density functions of the display primaries and the colorimentric properties of the human observer " [7].

Algorithm Description

At the beginning, the proposed algorithm is adding the red and the blue filter for the corresponding image. Next, we have to find the shift parameter between the two images, and then we cut the left and the right areas without 3D effect. Now, the images have a new dimension. As a result, we have to rescale the image. The image processing strongly affects the anaglyph image color. For this reason we have to adjust the brightness, contrast and saturation.

Finally, the actual overlap is achieved between the two images processed, resulting tridimensional image. You can find the logical scheme in Figure 4.

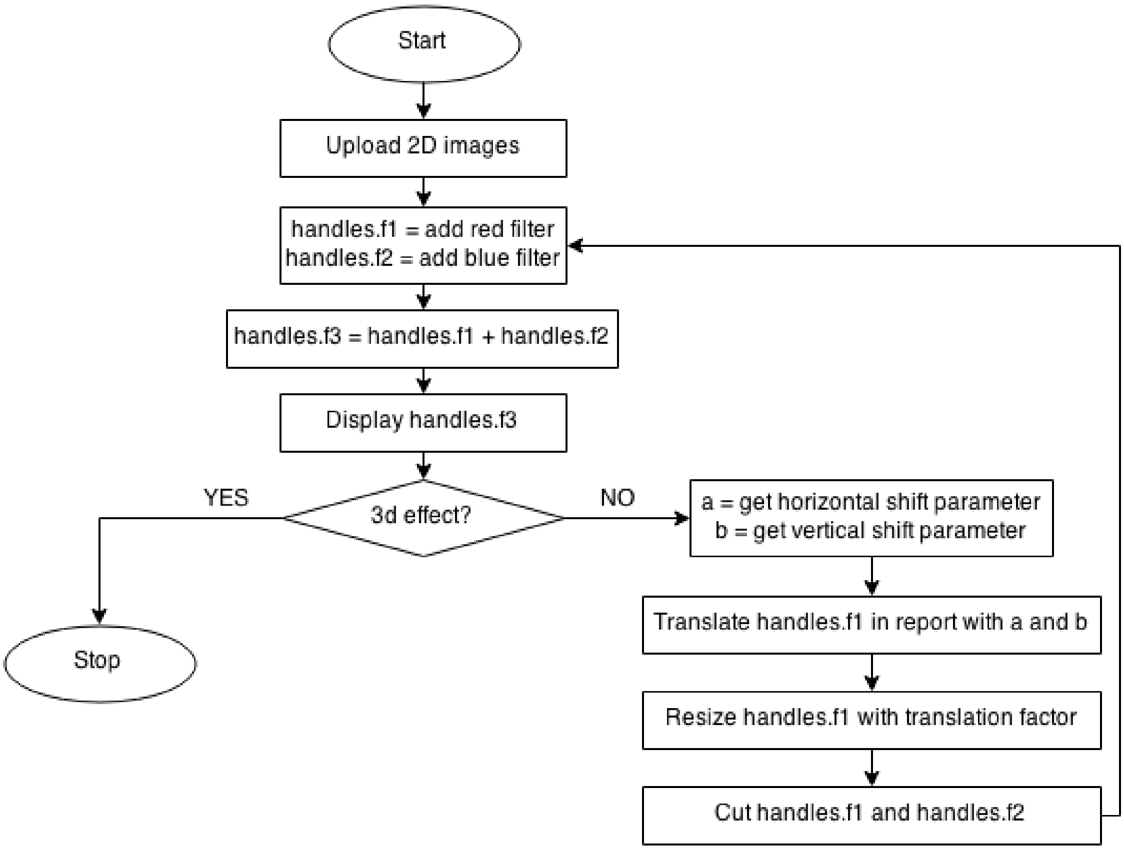

Fig. 4. Logical scheme for the anaglyph algorithm.

Figure 5 shows that the focused object has a position in the blue filter, but in the red filter the same object has an offset. For this reason, the first image has to be moved down so that the disc will overlap with the focused object in the second image. After this step, you can see in figure 5 that we have a black area without information. Cutting this area, we will have a new dimension for the blue filter. Resizing the image at this level will not solve our issue because it will resize the disc corresponding to the blue filter, so it will be impossible to overlap the two discs. As a consequence, we propose another solution. We will cut from the second image (red filter) the same area as for the blue filter. Next, we will resize both images.

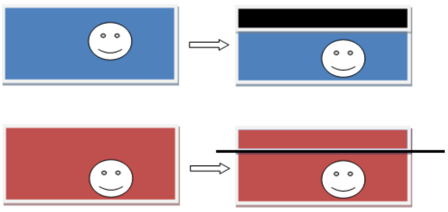

Fig. 5. Processing issues.

In this example (figure 5) we need to shift only horizontally the image, with *a* parameter. As result, the cutting area is located to the upper zone. So we need to keep the area defined by the coordinates $xmin = a$, $ymin = 0$, $xmax = d_1$ şi $ymax = d_2$ as one can see in figure 6a. If the cutting area is located in the lower zone, the coordinates are (0,0), $(0, d_2)$,$(d_1$-$|a|$,0),$(d_1$-$|a|$,$d_2)$ (see fig. 6b). If we need to shift vertically, we need to move the image from left to the right with a specified number of pixels quantified by the b parameter. The resulted coordinates are $ymin$ =

b, *ymax* = d_2, *xmin* = 0 and *xmax*= d_1 (fig. 6c). Otherwise, if we need to cut from the right side, we will have the coordinates *xmin* = 0, *xmax* = d_1, *ymin* = 0 and *ymax* = d_2 - |*b*|.

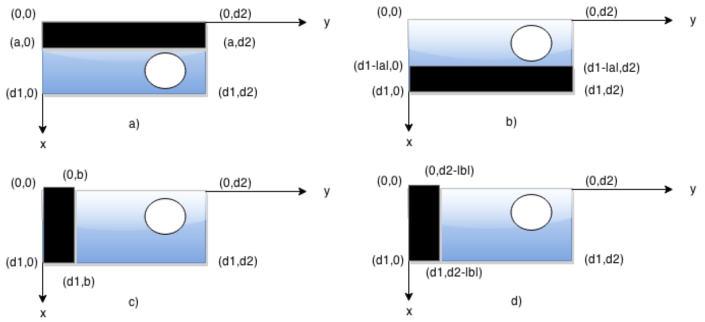

Fig. 6. Shift parameter.

Results

The algorithm was entirely implemented by using Matlab environment. In figure 7 one can see the application interface with all features described in this paper. The user can adjust the shift parameter as described in previous section, using horizontal and vertical offset. If the image quality is compromised, you can adjust the luminosity and the contrast factors.

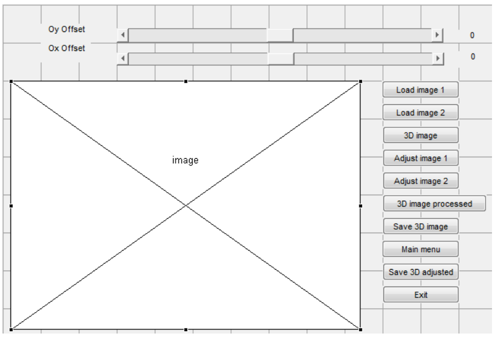

Fig. 7. Application interface.

Figure 8 depicts the 2D to 3D conversion. One can see the original 2D images and the resulted 3D image processed with our application that implements the presented algorithm.

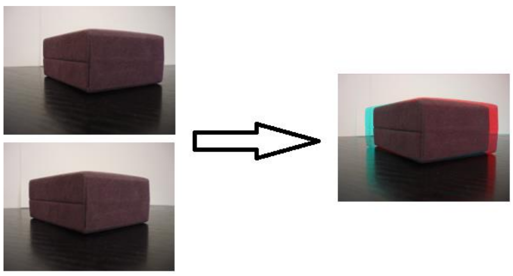

Fig. 8. Experimental results.

Conclusion

In this article, we introduced the general issues regarding three-dimensional technology. At the beginning we have presented the anaglyph technology based on red – blue filters applied on two images acquired with different cameras from different angles. If the distance between cameras and focused object is small, then the angle tends to 0 degree. For this situation, if we use only one camera it is enough to move the camera left or right when acquire data. We have presented a new algorithm that converts 2D images to 3D images. We have reconstructed the depth using the 2D images overlapping and we have presented a new solution in order to eliminate the areas without 3D effect.

References

1. Yun Zhang, Pingping Xie, Hui Li – Multi-scale colour 3D satellite imagery and global 3D Web mapping. *IEEE* 2007.
2. Youngmo Han – 2D-to-3D Visual Human Motion Converting System for Home Optical Motion Capture Tool and 3-D Smart TV. *IEEE Systems Journal*, Vol. 9, No. 1, March 2015.
3. Izmantoko, Y.S., Suksmono, A.B., Mengko, T.L. – Implementation of Anaglyph Method for Stereo Microscope Image Display. *International Conference on Electrical Engineering and Informatics*, 17-19 July 2011, Bandung, Indonesia.
4. Gallagher, A.C. – Detecting Anaglyph Images With Channel Alignment Features. *Proceedings of 2010 IEEE 17th International Conference on Image Processing*.
5. Yun Zhang – A New Automatic Approach for Effectively Fusing Landsat 7 as well as IKONOS Images. *IEEE* 2002.
6. Narasimhan Renga Raajan, Mohan Ram Kumar, Balakrishnan Monisha A. Jenifer Philomina, D. Parthiban, M.V.Priya – Camera Calibration For Stereoscopic Technique. *IEEE-International Conference on Advances in Engineering, Science And Management* (*ICAESM -2012*) March 30, 31, 2012.
7. Dubois, E. – A Projection Method to Generate Anaglyph Stereo Images. *IEEE* 2001.
8. Abdulkadir Iyyaka Audu, Abdul Hamid Sadka – Generation of Three-Dimensional Content from Stereo-Panoramic View. *55th International Symposium ELMAR-2013*, 25-27 September 2013, Zadar, Croatia.

Probleme de bază determinate de generarea conținutului multimedia tridimensional

Rezumat

Acest articol prezintă una dintre cele mai utilizate tehnici de generare a conținutului multimedia tridimensional, metoda anaglif. Această tehnică de generare a imaginilor 3D este foarte ieftină, ceea ce a permis studiul și utilizarea acestei tehnologii pe scară largă. Tehnica anaglif folosește filtre roșu – albastru aplicate pe două imagini achiziționate din unghiuri ușor diferite. Imaginile tridimensionale obținute pot fi vizualizate doar cu ajutorul unor ochelari bicolori, fără necesitatea altor dispozitive speciale de redare. Tot în această lucrare s-au prezentat problemele generale implicate de reconstrucția mediului tridimensional pe baza unor imagini bidimensionale. Pentru aceasta, a fost propus un algoritm care să recupereze efectul de adâncime. Validarea algoritmul s-a realizat pe baza rezultatelor foarte bune obținute cu ajutorul aplicației Matlab care implementează algoritmul propus.