Generation of 3D Image Sequences from Mixed 2D and 3D Image Sources

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ABSTRACT

3D graphic computers need image data having included sufficient depth information of objects or pixels. The integration of natural pictures or scenes from cameras into 3D image data is only possible if additional depth information is generated. This contribution describes a new procedure and algorithms to import 2D images into 3D sequences.

Keyword: autostereoscopic, 2D to 3D conversion, 3D imaging.

1 INTRODUCTION AND BACKGROUND

New autostereoscopic principles and displays have been presented last year at the icce (International Conference on Consumer Electronics) and at the SCI 2000, cf. [1], [2]. The embedding of natural 2D images or scenes into 3D still pictures or real-time scenes is now not only a scientific image processing problem but it is also already of commercial interest. General methods and file formats for 3D image processing have been standardized in MPEG 4: A special coding algorithm is not yet precisely described for generation and transmission of 3D image sequences. Therefore, some effort has been spent to develop mapping algorithms which can be used in the 3D PAM system (Position Adaptive Autostereoscopic 3D Monitor), cf. [1] as well as for the HOLDISP (Hologram Display), cf. [2].

2 DEPTH ASSIGNMENT PROCEDURE

Two dimensional photos or images of landscapes or of single objects might be given in JPEG or other compatible formats. They are scanned and stored in a digital file like JPEG. The file is converted into the flexible pixel format TIFF (Tag Image File Format), having defined spare capacity for the depth positions of pixels. The photo is copied and shown on a standard monitor. There might be some typical points on the picture which have a-priori known depth positions with respect to another point or to the point from which the photo has been taken, like the corners of the house, shown in Fig. 1. This relative depth values can be entered and assigned to the chosen pixel or corner in any measure (mm, m, feet, or else). In this way where three points form a clear plane, a triangle is assigned to this three marked points.

An automatic or manual triangulation assignment procedure can be chosen. Fig. 2 shows such an arrangement of neighboured triangles. At the end of this entering task each point of the photo belongs to at least one triangle or it might belong to background region or to a transparent one. In case of depth jumps overlapping triangles can be defined where in the covered regions the image type features are automatically continued. The depth positions within a triangle is geometrically given by a plane through its three corners. But the plane calculation itself that is to say the depth calculation of each point within the triangle is preferably done later on - when the projection algorithm is started. If simple objects are given like the house in Fig. 1 no much data must be stored additionally. Of course, if a more precise assignment is needed for more detailed regions the number of triangles can be increased easily: chose a point within a triangle and assign a further own depth value.
The old triangle is substitute by three new ones. In case a border line is met, the old triangle is substituted by two new ones.

Subdividing the triangle more and more a very dense net of a 3D surface can be designed and shown on a 3D screen. In case more objects in very different depth positions are to be three dimensional enhanced it is preferable to use different photos and to integrate them later on by the 3D projection. In this way, normally hidden regions can be integrated while certain regions can be set transparent.

3 THREE-DIMENSIONAL PROJECTION

Different Photos can be composed into one scene after having got its depth profiles. Each photo is placed by a transformation of seven parameters into the projection scene: 3 parameters for translation, 3 parameters for rotation and one for stretching. Then the projection algorithm is started. From each pixel of the 2D picture two projection rays are drawn from the new (x,y,z)-position to the eyes of the virtual observer. The break-through points for 3D display are calculated and at this point the coordinates, the colors, the depth values (or region features) are stored with respect to the pixel size and position in the plane in which the display is arranged later on for the 3D presentation. In case another ray has already met this point the depth positions and features are compared and the point with the lower depth position is registered for the right view and for the left view. Fig. 3 show a projection from one point to two eye positions through the display plane.

Normally more rays meet a display pixel. Therefore a easy filtering procedure has to be applied. That projection pixel which meets the display pixel in the middle is only used for this display pixel, while the others are distributed over this and the neighbored display pixel with suitable weight to get the resulting color information as the mean value. It may happen that neighboured pixel of the original picture with slightly different depth position meet the same display pixel on different points. Therefore the pixels carrying the lowest depth value within a certain given interval are registered. In case the projection pixel difference on the display coming from one object is higher than the double of display pixel difference, an other filtering rule is used.

In this way one original photo or object after the other is scanned pixel-wise mapping views of the whole scene on the display plane. There exist already multi viewer 3D displays. For those displays it is necessary to take as much view projection as the display offers up to 100.

Figure 1: Original 2D-Photo.

Figure 2: Triangulation plan having depth positions and background information.
4 DISPLAYING

The mapped pictures belonging to two eye projections can be displayed autostereoscopically on a 3D PAM monitor (Person Adaptive Autostereoscopic 3D Monitor) or on other 3D monitors. If a head tracker is used to detect the eye positions multiple stereo views can be displayed sequentially according to a observer position movement. Without a head tracker all views might be shown sequentially by a software program that turns the scene.

There exist multi viewer 3D system that show up to 100 view directions in parallel like the Hologram Display [4]. Then a very natural 3D impression is realized.

5 APPLICATION AREAS

The direct application is the generation of 3D images for the hologram display. The observer-adaptive PAM monitor shows all possible stereo views and helps to select the viewing range to be stored on a hologram photo display. For future applications the whole 3D scenario will be coded automatically into a vector format again to be stored, easily transmitted and regenerated in real time by a 3D graphic board. In this way natural pictures and photos can be integrated into given 3D scenes for example into games.

References


