Simulation of blur in stereoscopic image synthesis for virtual reality

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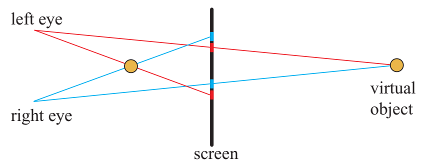
ABSTRACT

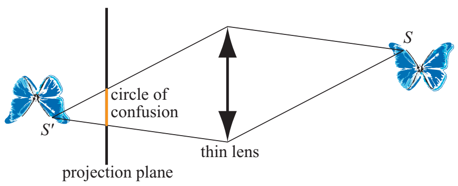
This paper proposes a method permitting to generate synthesized images including blurred area in real time in order to help stereoscopic perception in virtual reality systems. At any time of the process, the combined knowledge of the scenario and the position of the user in front of the screen allows to select automatically the important zone of the scene. The elements associated to the clear zone catch the attention of the user while the blurred areas avoid an excessive eyestrain. First, we present several methods permitting to simulate blur effects produced by a thin lens in image synthesis. Then we develop our work on the adaptation of the previous methods in the stereoscopic images context, illustrated by many results generated in our own virtual reality system. Finally, we propose different solutions for the treatment of the interdependence between scenario and interactivity in image synthesis animations.

The main goal of our work consists in both simulating in real time the perception of stereoscopic images including the depth of field in order to catch the interest of the user in the important areas of the scene, and reducing excessive eyestrain. Adding blur in synthesized images allows us to mask the low interest areas of the scene.

STEREOSCOPIC IMAGES

The stereoscopic images principle consists in associating to each eye an image of the same scene but with a different point of view. Thanks to a pair of filter glasses, the user fuses these two images in order to throw the scene into relief. We can notice on this figure that when an element of the scene is isolated from the screen before or behind it, this element appears at very different positions on the two stereoscopic images. Under theses conditions, the mental reconstruction of a 3D image becomes exhausting even impossible.





SIMULATION OF THE HUMAN VIEW

We can assimilate the human eye to a thin lens able to modifiy the focal distance change in order to place the user attention on a precise point of the scene (accommodation phenomenon).

This thin lens refracts the light rays coming from a point S of the scene to an image point S'. If S' is different from the projection plane, a stain appears in the projection plane. The size of this stain is defined by the circle of confusion that is at the origin of the blur effects.

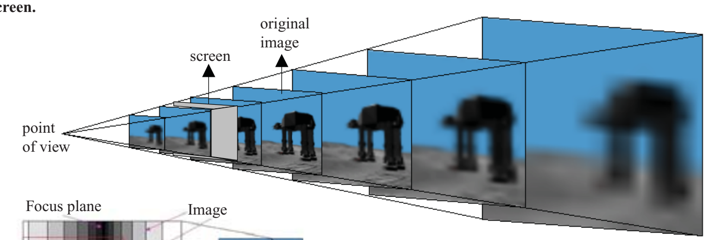
This figure presents a simulation schema of the human vision used in the viewing device. The retina corresponds to the projection plane which receives the final image, the crystalline lens is simulated by a thin lens placed between the virtual scene and the screen.

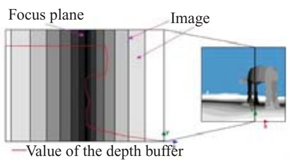
REAL TIME RENDERING WITH BLUR

A rendering method, mainly used in video games, permits to add blur in real time synthesized images. We consider that a low resolution image appears blurred due to the calculation method of the pixel color as an average of its neighbors color. This method consists in calculating the images for a set of sub-resolutions (mipmaps), and for each pixel, the size of the circle of confusion deduced from the depth map permits to know which one to select.

The main advantage of this method is the exploitation of two hardware functions: the computing of sub-resolution image and the creation of the depth map included in the depth buffer algorithm.

In the stereoscopic images context, with the addition of the notion of plan of convergence different from the focus plane, we have to improve the method presented in the last paragraph. Our method consists in placing a set of blurred images behind and before the focus plane as shown in this figure.

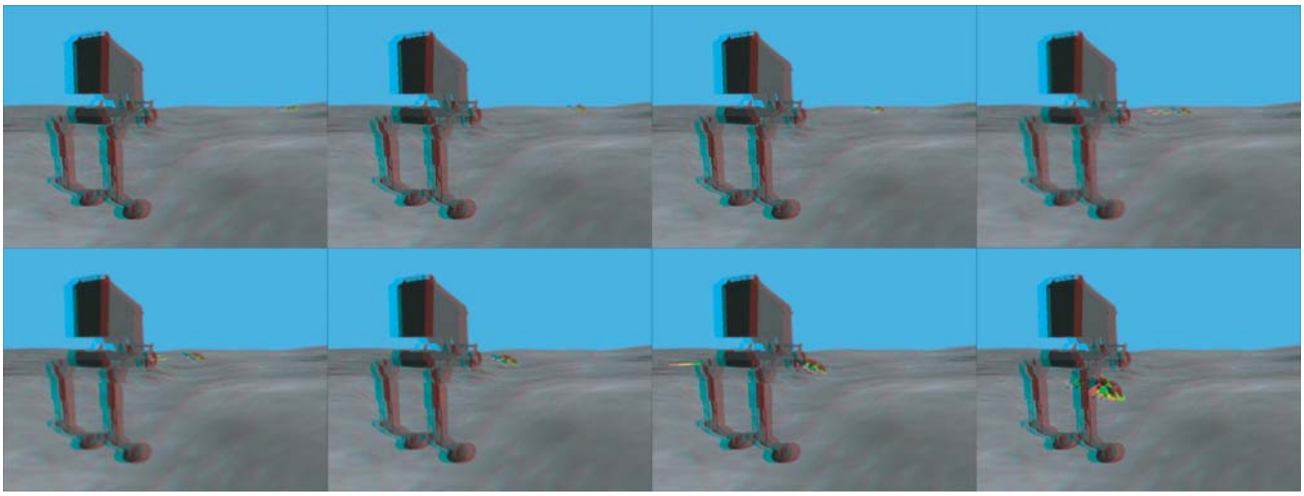




PLACING THE FOCUS PLANE ACCORDING TO THE MOVEMENT OF THE USER

The degree of freedom of the user can be increased by using his position and orientation in the virtual scene to find the position of the focus plane. For example, the unblurred object is the one in front of the user. Also to place this plane, we use morphological parameters of elements in the image, in this way the user will pay attention, for example, to the biggest object on the screen.

We can also use this sort of navigation in the context of virtual visits in a museum where several works of art are shown. A set of rules are used to place the focus plane on the art work corresponding to the position of the user as shown in this figure.



PLACING THE FOCUS PLANE ACCORDING TO A SCENARIO

Several objects of our scene have more importance than others. To accentuate this notion we can use a scenario (described as a sequence of actions) to modify the position of the focus plane during the animation. For a given time t, the scenario changes the geometrical (form, position, size, direction, displacement, ...) and radiometrical (color, camera, lighting, ...) characteristics of the objects to get the visual result we are looking for. With this aim, we use a script file to execute a set of commands at each important moment of the scenario.