Modified Shutter Glasses for Projection and Picture Acquisition in Virtual Environments

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Abstract

Virtual reality can be extended to create a collaborative distributed environment over a physical network. Such an environment can only be established however, if both, virtual objects and the other users, can be seen simultaneously in real-time. This requires a novel technique to overcome the contradicting requirements of darkness and light for image projection and video acquisition, respectively. In order to make an inexpensive and easy to build solution, a camera acquisition system and a stroboscopic light are added to the existing VR-system. Modifications are made to existing shutter glasses to handle simultaneous projection and video acquisition. In such a solution, the method of projection in the VR-system remains unmodified. The poster describes how to resolve the conflict between the darkness required for projection and sufficient lighting necessary for video acquisition.

1. Introduction

More and more VR installations are set up worldwide [1]. Most of these installations are stand-alone, where the user is shown synthetic, computer-generated objects. Although present computing tools support information exchange and simple communication fairly well, collaboration on complex issues - be it models of functions, form or behavior - is not well supported. Most of the VR systems use CRT-projectors to display full-color, computer-generated stereoscopic images on the walls of a cube. The user can only experience this stereoscopic effect by wearing active stereo glasses, which alternately block the left and right eye.

A new project called „blue-c" [5] proposes to build a system that achieves the following two major goals. The first goal is to enable a number of participants to interact in a virtual meeting and a collaborative setting, where the representation of people and objects is as complete as possible, in other words all objects and persons are fully rendered in three-dimensions with real-time movement and speech. The second goal is to provide an interaction between all the users and the simulated artifacts, be they models of function, form, behavior or their combination. The advantage of such simulations is the improvement of telepresence in conference meetings and creation of immersive, virtual multi-user environments.

For this purpose a simultaneous projection and picture acquisition is needed. The key problem with simultaneous projection and picture acquisition is the illumination of the scene. On the one hand, to achieve a high quality image acquisition, a well-lighted scene is necessary. On the other hand, the projection system requires dark surroundings for a bright and sharp picture. However, the illumination coming from the projection is not sufficient to acquire the correct texture. Since the projected image is normally different from solid white, any texture will have the wrong colors in the video images.

In order to overcome these conflicting lighting requirements, a new approach is used in the „blue-c"-project. The basic idea is to illuminate the „blue-c" actively with a stroboscopic light source during video image acquisition. The stroboscope will be synchronized with the cameras, the projectors and the shutter glasses, that are needed to generate stereoscopic views in such VR Caves.

2. Contributions

In order to simultaneously provide a good projection and a good image acquisition, two different illumination phases are necessary. In a dark phase the spectator can watch the projection and in a light phase the camera can acquire the person's texture.

Our approach uses a flash to illuminate the person in order to get the texture. During the flash, the spectators eyes are covered by a new, third phase of the shutter glasses, where the glasses become opaque. If the phase sequence is done fast enough, human perception fails to follow the oscillation from light to dark.

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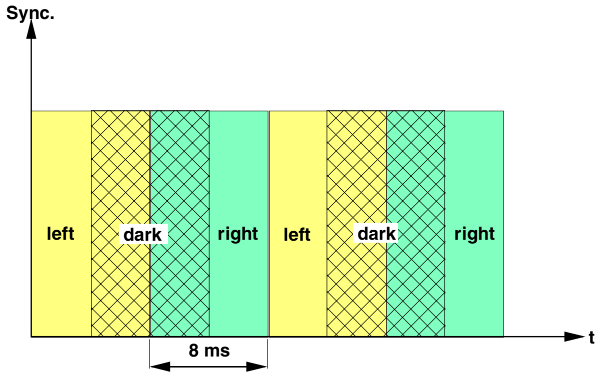

Figure1. Time multiplexing diagram

Figure 1 shows how the original two states of the shutter glasses are supplemented by a third state, which darkens both the left and the right lenses simultaneously. This dark phase is used to shield the user's eye from the stroboscopic illumination. Each of the original states, one for the left and the other for the right eye, is shortened in order to create a third state. If this third state is kept very short, it will not be detected by the spectator's eye. However, regardless of how short the new state is, the overall picture will appear slightly darker because of the decreased light integration (exposure) time for the left and the right eye. Consequently, the dark phase is made to be as short as possible. The actual value for the dark phase is constrained by the following:

- the minimum required time (to grab a video frame) for an exposure (dictated by the shutter speed)
- the maximum switching frequency of the shutter glasses
- the minimum time of the flash (including the afterglow time)
- the maximum rise time of the flash
- the latency time of the additional electronical circuitry

3. Placing the third phase

For human perception, it is important that the new dark phase is symmetrical to the original phases for the left and the right eye. The third phase is placed during the transition from the original dark phase of the left eye to the dark phase of the right eye.

4. Experimental results

In order to demonstrate the effectiveness of the modifications, the illumination of the object was viewed with and without a third phase. Figure 2 shows the difference between these two results.

The illumination was the same for both images. The left object in each of the two images was illuminated with a flash while the right object was illuminated with ambient light. Both images have been taken through the shutter glasses. In the left image, the shutter glasses were not modified, while in the right image the third phase was added.

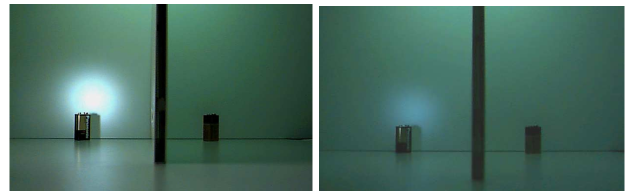

Figure 2. Illumination viewed without and with the third phase

5. Conclusions

The basic measurements and the first test results from the setup proved that it is possible to integrate active illumination into a stereoscopic viewing system and perform texture acquisition of objects and people inside the system. A third phase (dark phase for both eyes) within the shutter glass protects the user's eyes from this additional illumination. The timing frequency of this third phase can be chosen to be fast enough so that the human eye cannot resolve it.

The new technology is compatible with existing VR-systems and incurs low additional costs from the modified shutter glasses.

This basic technology will allow the development of new applications of virtual reality within a collaborative framework.

6. References

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