LIFLET: Light Field Live with Thousands of Lenslets

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Figure 1: LIFLET can handle occlusion, reflection and refraction.

1 Introduction

LIFLET, which stands for Light Field Live with Thousands of Lenslets, is a 3D live video system. This is not a 3D display technology, but a real-time image-based rendering system that is applicable for living things and complex reflection and refraction in the real world. Figure 1 shows examples of synthesized free-viewpoint images of real scenes.

2 LIFLET

LIFLET has a Fresnel lens, a GRIN lens-array, an IEEE1394 XGA camera, and a PC. Figure 2 illustrates a diagram of the system. The Fresnel lens helps the GRIN lens-array to pick up wider range of a scene by controlling the depth of field. The GRIN lens-array produces thousands of elemental images (for instance, 50×40 images of 20×20 pixels). The PC synthesizes free-viewpoint images from the elemental images captured by the IEEE1394 XGA camera.

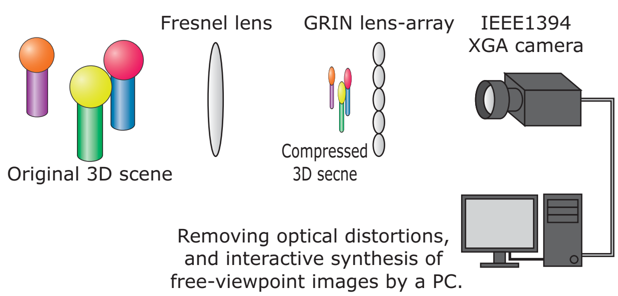

Figure 2: A schematic diagram of LIFLET.

LIFLET offers four technical innovations:

- A simultaneous capturing system with thousands of lenslets mentioned above. This system can capture thousands of views of a scene simultaneously, while the camera array system can capture up to tens or hundreds of views [Naemura et al. 2002].
- An interactive method of displaying free-viewpoint images of dynamic scenes. From the captured thousands of views, we can synthesize free-viewpoint images interactively. The whole process from capturing to interactive display is performed in real time.
- A software approach to remove optical distortions. In order to extend the depth of field, we introduce the Fresnel lens. Unfortunately, this lens causes undesirable optical distortion. We apply the concept of ray tracing to remove the distortion [Yamamoto and Naemura 2004].
- A real-time method for estimating view-dependent depth map from the elemental images. The depth map is optimized for each viewpoint, and applicable for enhancing the quality of the synthetic images.

3 Experimental Results

Synthesized free-viewpoint images are shown in Fig.1. Viewpoint is moving around while the capturing system is physically fixed. You can see the occlusion effect by a hole, the mirror reflection effect and the water refraction effect. The authors have confirmed the correctness of synthetic views by measuring the parallax appeared in each view [Yamamoto and Naemura 2004].

4 Conclusion

This is the beginning of true 3D live video, which could introduce new digital media such as digital holographic video. It is suitable for various applications, including 3D broadcasting, 3D photometric archiving, and 3D content creation for movies or games. We are planning to extend and improve the optical system to achieve higher resolution of images.

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References

NAEMURA, T., TAGO, J., AND HARASHIMA, H. 2002. Real-time video-based modeling and rendering of 3D scenes. *IEEE Computer Graphics and Applications 22*, 2, 66–73.

YAMAMOTO, T., AND NAEMURA, T. 2004. Real-time capturing and interactive synthesis of 3D scenes using integral photography. In *IS&T/SPIE Electronic Imaging 2004, Stereoscopic Displays and Applications XV*, vol. 5291A.

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