X-SectionScope: Cross-Section Projection in Light Field Clone Image

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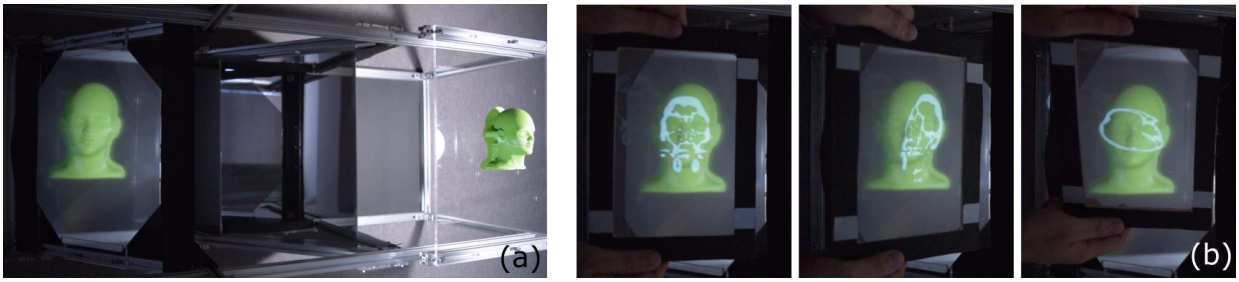

Figure 1: (a) Human head model and its Light Field Clone (LFC) image.
(b) CT images projected on a semi-transparent handheld screen inserted in LFC image.

Keywords: cross-sectional image, aerial image, 3D display

Concepts: • **Human-centered computing ~ Visualization;** *Visualization theory, concepts and paradigms;*

1. Overview

In this paper, we propose a novel interactive 3D information visualizing display that superimposes a cross-sectional image in an aerial volumetric image of an object. Figure 2 shows a system configuration. A user can see internal images of the object, such like an X-ray image, by inserting a semi-transparent handheld screen in a cloned floating image. We use two Micro Mirror Array Plates (MMAPs) to reproduce a Light Field Clone (LFC) image. The MMAP (Aerial Imaging Plate, ASUKANET. Co., Ltd.) was designed for reconstructing aerial images in midair based on double reflections. The LFC image is a reconstructed floating 3D image which can be seen without wearing any glasses. In the HaptoClone system [Makino et al. 2015], they proposed the use of two MMAPs to reproduce LFC image of the object. By contrast, we use additional two general mirrors in the proposed system. With this configuration, the realistic LFC image appears next to the object keeping the facing direction same. Users can see both the real object and its cloned image at the same time.

When a semi-transparent screen is inserted into the LFC image, the system projects the cross-sectional image of the object on the screen. We use a silk screen, a fine meshed-fiber screen, as the projection screen, which was used in the previous study [Furuyama et al. 2015], for superimposing 2D image without disturbing a 3D image. The position and posture of the screen are estimated by capturing optical markers attached on each corner of the screen. A user can slice the realistic LFC image with the handheld screen. Reconstructed floating 3D image gives a cue where to insert the screen to find a particular point.

Figure 3 shows a prototype system named X(cross)-SectionScope. A user can see the floating volumetric image at the same height as the real object.

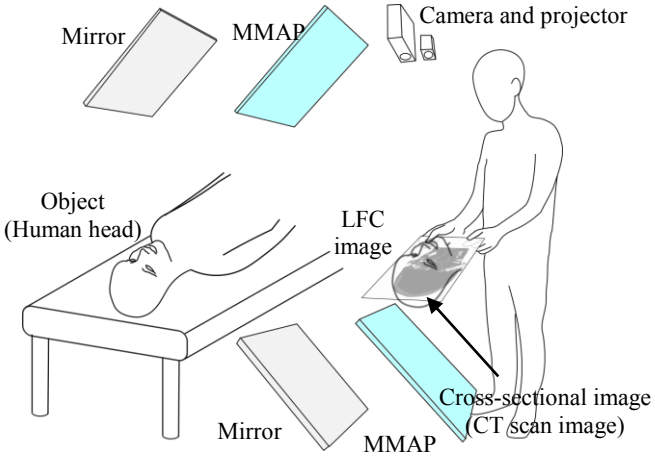

Figure 2: System Configuration.

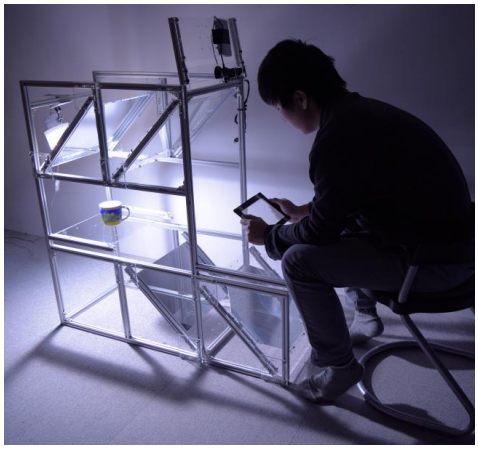

Figure 3: Prototype System: X-SectionScope.

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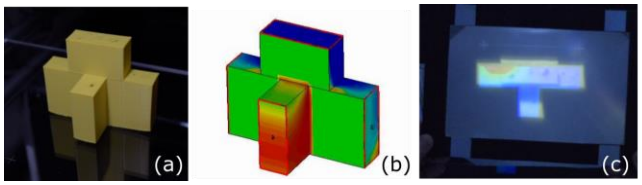

Figure 4: Visualization of simulation result of the waveguide. (a) Waveguide model. (b) Simulated 3D electromagnetic field. (c) 2D field distribution is projected on the screen.

2. Applications

By using our system, 3D structural information is visualized as a sliced 2D image on an arbitrary plane. Figure 1 shows an example of visualizing inner images of the scaling-down human head model. The cross-sectional image of the cranial bones can be seen depending on the position and the tilting angle of the screen. Our visualizing method can be effectively used in medical field. In the case of surgery, as is illustrated in Figure 2, doctors can see both an original patient body and his/her cross-sectional images projected inside his/her cloned body image.

Another demo is to visualize numerical simulation results. The results are conventionally displayed on 2D screen. Users need to choose a particular plane to see inner distribution of 3D field such as an electric field, a sound pressure, and so on. By using the proposed system, users can see the simulation results from different perspectives intuitively by inserting a screen by their own hand. We show a visualized result of an electromagnetic field in a waveguide, a 3D circuit element for electromagnetic wave (Figure 4). When the screen is inserted in the LFC image of the waveguide model, the 2D field distribution is projected on it.

The system can be used for 3D CAD modeling for architectural design. Figure 5 shows another demonstration that enables users to see inside the house model. They can see both the exterior and interior at once and the interior information on each floor.

Users can visualize internal information by combining the proposed system with a non-destructive inspection. For example, it might be possible to see internal condition of vegetables or fruits as shown in Figure 6.

3. Related Work

Lots of interactive cross-sectional displays was proposed. There were some studies that combines a 3D aerial image and the cross-sectional image. Floating Volume Viewer [Sawada et al. 2012], a 3D aerial image display using convex lenses, displayed a 3D image that could be cut away with a transparent acrylic plate. X-Dimensional Display [Furuyama et al. 2015] simultaneously displayed both a simple 3D volumetric image in midair and the cross-sectional image projected on a semi-transparent screen inserted in the 3D image.

The biggest difference from these related works is that a realistic 3D image of any object is reconstructed without sensing the object. The LFC image is produced by transferring the optical light field. Therefore, the 3D volumetric image of the object spatially and temporally synchronizes with the motion of the original object. A user can handle both the original 3D object and a slicing plane with his/her own hand.

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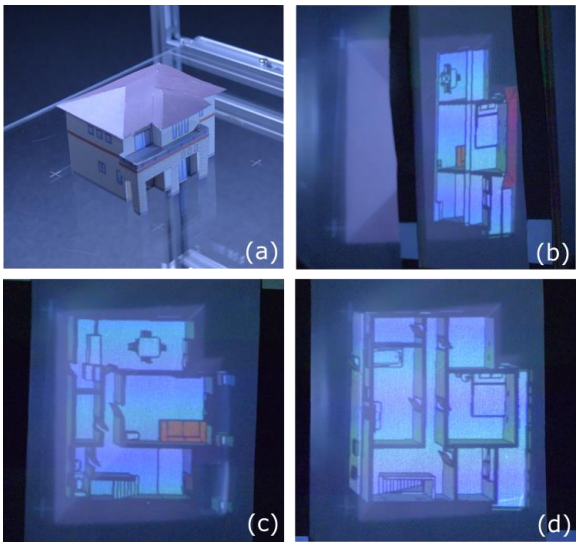

Figure 5: Architectural model. (a) House model. (b) Vertical section view. (c) Cross section view on the first floor. (d) Cross section view on the second floor.

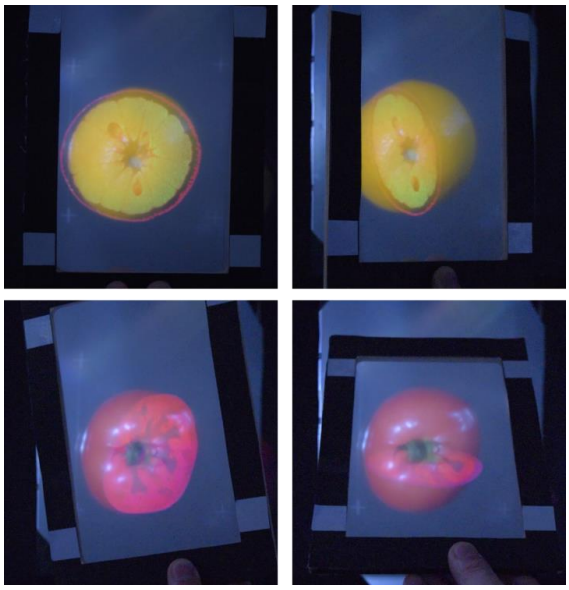

Figure 6: Internal condition of vegetables. (Top) Orange. (Bottom) Tomato.

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