Mixed and Augmented Reality Innovations in Beijing Institute of Technology

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Beijing Institute of Technology (BIT) was founded in 1940. BIT is a national key university, an open, international and research-oriented university of science, engineering and humanities with science and engineering as the focus. Beijing Engineering Research Center for Mixed Reality and Advanced Display(Beijing Institute of Technology) focuses on the research in the area of 3D display, human computer interaction, human factor, computer vision, Virtual Reality, Augmented Reality and their applications.

We have presented a novel method for automatically calibrating a multi-projector system in a non-planar environment without using 3D reconstruction, as shown in Figure 1. The proposed method corrects the geometric calibration error caused by the screen's manufactured imperfections, such as an undulating surface or a slant in the vertical plane. The constraints between the adjacent projectors are applied to refine the calibration result. To minimize the texture alignment error, a Bezier interpolation-based image-morphing method is adopted to adjust the projected image.

Figure 1. Result of image adjustment with unconstrained control point (left). Result after geometric calibration (right).

A new constrained color-matching algorithm that removes the color variations is proposed, in which all the color gamut of the projectors is mapped into a common gamut that can be produced by all the devices in the system, as shown in Figure 2. The smoothness constraints on the difference between two adjacent pixels are taken into account to calculate the luminance attenuation map of each pixel in the overlapping region to achieve the luminance seamlessness. The validity and superiority of this correction algorithm has been verified.

Figure 2. Two frames of a video rendered onto the car model.

An ultra-light wide-angle eyepiece is designed on the model of Takahashi's free-form prism structure. To achieve a wide field of view of 45°×34° and an exit pupil diameter of 8 mm with a 0.61" OLED, three XY polynomial surfaces are employed and optimized. The design layout, the OST-HMD prototype assembly and the setup for the optical see-through mode with a compensating optical component are shown in Figure 3 and Figure 4 respectively.

Figure 3. The eyepiece design layout and the HMD prototype assembly.

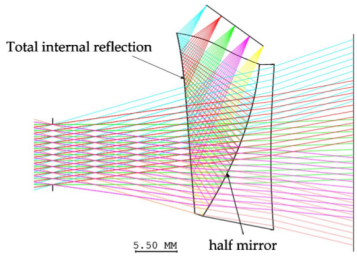

Figure 4. The setup for optical see-through mode.

A fast recalibration method based on an equivalent camera model is investigated to improve the calibration result according to the error source of the system. The interface for the hand registration information is also presented. The proposed system consists of an RGB camera, a depth camera and an OST-HMD. As shown in Figure 5, the blue arrow denotes an off-line process, and the red arrow denotes an on-line process. The fast recalibration method relies on the simple user feedback information and no additional device is used. Based on the proposed method, we can quickly recalibrate the OST-HMD when new users arrive.

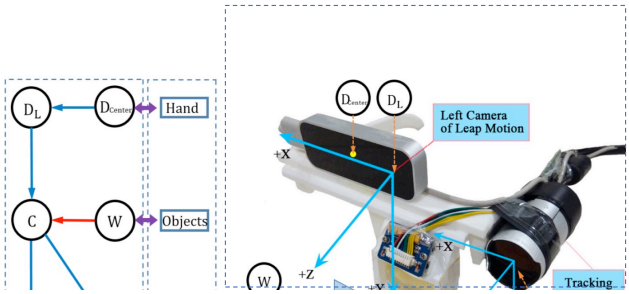

Figure 5. The structure of the proposed system: The relationship between the coordinate systems (left). The correspondence between the symbols and the components (right).

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