A Nested Marker for Augmented Reality

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Abstract

Nested Markers are a type of visual marker for HMD (Head Mounted Display) calibration in Augmented Reality. They have smaller markers nesting inside it. The largest marker visible from the HMD is dynamically selected according to the distance from the HMD. It enables AR scenes to be viewed close-up.

1 Introduction

Marker-based AR (Augmented Reality) systems are widely used for HCI applications, because they can be easily implemented. The ARToolkit is a well-known toolkit for calibrating an HMD camera in an AR system using a square-shaped visual marker [Kato and Billinghurst 1999]. Since the accuracy of camera calibration depends on the appearance of a captured marker, the size and layout of the marker should be carefully considered. However, when the positional relationship between the camera and the marker changes, the captured appearance also changes. It is often difficult to calibrate the camera when an observer tries to watch an AR scene in close-up, because the marker cannot be fully observed within the image frame. On the other hand, when an observer tries to view the AR scene from a distance, the accuracy of calibration is strongly affected by quantization errors. This is because the marker looks too small.

In this paper, we propose a hierarchically structured visual marker, the Nested Marker, which enables accurate calibration to be maintained even when the observer is viewing the marker close-up or from a distance.

2 The Nested Marker

As illustrated in Figure 1, the Nested Marker has a recursive layered structure. The nested marker has one marker in the upper layer and four smaller markers in the lower layer. The smaller markers also have lower-layer markers nesting inside them. Every marker at every layer is designed to be identified by its interior pattern, which may be composed of lower-layer markers. The largest marker visible from the HMD camera is dynamically selected according to the distance between the observer and the marker. When the observer views close with the marker close-up, it is the lowest-layer marker that works. When the observer views looks far from the marker from a distance, it is the top-layer marker that works. Each marker can be identified by its interior pattern, so the system can select the appropriate calibration parameter set for the marker. It is also possible to utilize all the visible markers in different layers simultaneously for a more stable calibration. OWe should note that our Nested Marker is suitable for use in the standard ARToolKit framework.

3 An Experimental Implementation

We developed an AR system using the Nested Marker. We designed the Nested Marker with three layers. The size of the top-layer is 8 cm square. The sizes of the second and the third layer markers are 2.5 cm and 0.8 cm, respectively. The input video size captured with a USB camera is VGA (640 x 480).

Figure 2 shows some screen shots of the AR system with the Nested Marker. The views are observed from 4 cm, 21 cm, 38 cm, and 55 cm. They effectively demonstrate the Nested Marker’s abilities.

4 Conclusion

The Nested Marker is a novel visual marker that works in the standard framework of ARToolKit. It enables a close-up view of an AR scene and is effective for enlarging an observer’s visual range.

References