Interaction in Augmented Reality using Non-rigid Surface Detection with a Range Sensor

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Abstract. This paper describes an interaction system with computer graphics represented in augmented reality (AR) through deforming of a target object as an input method. Although some studies using only single cameras have achieved non-rigid surface detection in real time, a range image sensor has the possibility to make the detection easier. Because range image sensors have become widespread in general recently, it is more reasonable to use it for non-rigid surface detection rather than a single camera. The proposed detection method by a range sensor would be a suitable interaction technology since a surface that has no feature points can be also measured. For a practical use case scenario, the interaction system will be applied to an AR picture book solution.

Keywords: augmented reality, human computer interaction, non-rigid surface.

1. Introduction

Augmented reality (AR) technology has become quite widespread in general recently and thus general population has experienced AR through games, applications for smart phones, state-of-the-art technologies in exhibitions, and so forth. In such AR experiences, many users would often try to interact with the computer graphics (CG) that don't exist in the real world. For example, the users were trying to touch the CG images, or shake the marker. That means people were hoping to interact with visible information instinctively. This is an important point for AR interface design. Gesture recognition and tool-usage studies have been done for such interaction methods. However, there are few studies that apply deformation of the marker objects as an input interface. This paper describes an interaction method that changes CG animation based on the deforming operation of the target objects as an input interface.

Detection technology of deforming non-rigid surface that has feature points has been applied into the field of AR by using one camera [1, 2, 3]. These studies enable displaying of CG on deformed markers as AR representations because the shape of marker is estimated using feature points. Recently, the non-rigid surface detection has a real time processing advantage over the use of a single camera and has become one of interaction technologies.

On the other hand, it is reasonable to use a range image sensor for measuring scene structure on the point of obtaining measured result in a moment. Hence, the range sensor way would detect non-rigid surface easier than image based non-rigid marker recognition. This study tackles this detecting method using a range sensor. Additionally, a range sensor can detect non-texture surfaces while image based method cannot detect such a surfaces.

2. Method

The proposed system consists of a color camera, a range image sensor, and a computer. It is a simple configuration that obtains color and depth information by a camera and a range sensor respectively. The transformation matrix between a camera coordinate system and a range sensor coordinate system are assumed known by calibrating them in advance. In the proposed system one condition, that target surface doesn't change its own size, is set. Under this condition, a curved surface that fits the shape obtained by the range sensor can be calculated.

At first, feature points on the target surface are detected via a color camera. Then, these three dimensional coordinates are calculated based on corresponding range data. The curved target surface, which has a constant size, is estimated using this data. At the same time, the system can measure the structure of a real world space where the target exists. Finally, the CG animation changes depending on the shape of target surface and the real world space around the target. For practical use, the system will be applied as an interaction method for an AR picture book. Figure 1 shows the proposed interaction method compared with a conventional AR picture book.

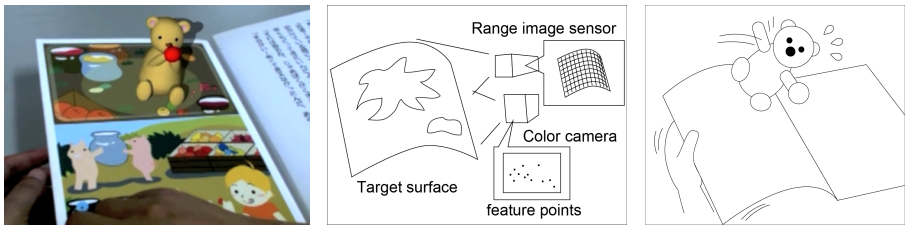

Figure 1. Left figure shows an AR picture book made of hard carton boards, middle figure is configuration of the proposed system, and right one is an example of the interaction system.

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