Interaction with Virtual Shadow through Real Shadow using Two Projectors

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Abstract

In this paper, we propose a method to interact with virtual shadows through real shadows various physical objects by using two projectors. In our method, the system scans physical objects in front of a projector, generates virtual shadows with CG according to the scan data, and superimposes the virtual shadows to real shadows of the physical objects with the projector. Another projector is used to superimpose virtual light sources inside real shadows. Our method enables us to experience novel interaction with various shadows such as shadows of flower arrangements.

Keywords: Interaction, Shadow, Scene Scanning, CG

Concepts: • **Human-centered computing ~ Human computer interaction;** *Interaction techniques;*

1 Introduction

In this research, we propose a method to interact with virtual shadows through real shadows of physical objects. Shadows are easily generated with physical objects and a light source, and they are also used for entertainment such as shadow play and shadow art. Thus, there are several researches that realize interaction with shadows by using CG technologies [Xu et al, 2006] [BIG SHADOW, 2006].

Our method is based on simulating real shadows by scanning physical objects in front of a projector. The system takes not only depth data but also color data and joints data, and identifies each physical object. Then, the system generates virtual shadows based on identified physical objects, and superimposes them on real shadows. As the result the system realizes various interactions with virtual shadows through various real shadows. Our system uses another projector to project virtual light sources inside real shadows, and it is possible to make holes in or deform the real shadows.

2 Methods

The proposed system is composed of two projectors, a screen, a PC, a Kinect, and physical objects for generating real shadows as shown in Figure 1. The first projector is used both for projecting virtual shadows and a light source for real shadows. The second one is a short focal distance type used for projecting virtual light sources inside real shadows.

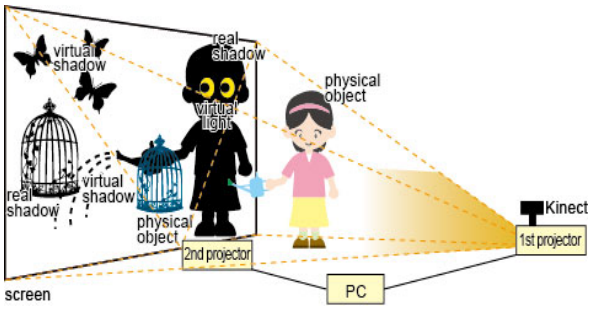

Figure 1: *The overview of the system.*

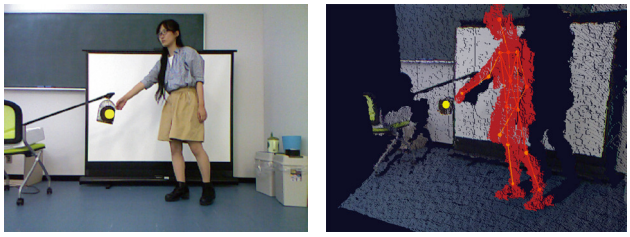

Figure 2: *Scanning a scene in front of the projector, and detecting a bird cage and a user based on depth data.*

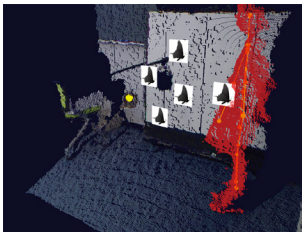

Figure 3: *Generating virtual butterflies in a 3DCG space for virtual shadows.*

The Kinect takes depth images and color images in front of the first projector as shown in Figure 2. When a user stands in front of the screen, the Kinect also detects the positions of the user's joints. The system identifies each physical in front of the first projector and generates 3D data of the real scene. The PC has a virtual scene whose viewpoint and projection plane are the same as the position of the projector and the screen of the real scene. Thus, when the system renders 3DCG images of the scanned data and projects them on the screen with the projector, the position, the shape, and the size of the images would be the same as those of real shadows of the physical objects, and it would be simulations of real shadows.

Then, the system generates virtual objects in the virtual scene based on each physical object as shown in Figure 3. The kind, the position and the motion of each virtual object would be changed according to those of the corresponding physical objects. Virtual shadows are generated by rendering 3DCG images of the virtual

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objects and projecting them on the screen. Virtual light sources are also generated by rendering and projecting virtual objects inside real shadows with the short focal distance projector. The virtual objects move according to the movement of physical objects. As the result, virtual shadows and virtual light sources move according to the movement of the real shadows. The user would feel as if interacting with virtual shadows by real shadows.

3 Experiment

We developed an application based on the proposed system. Physical objects for real shadows are a birdcage, a watering can, a flowerpot, a pumpkin, and a user. The system could identify each physical object based on depth data, color data and joints data, and the user could interact with various virtual shadows through various real shadows of physical objects as shown in Figure 4. The second projector could make holes in real shadows by projecting virtual light sources inside the real shadows of a user and a pumpkin (Figure 3(b)(c)(d)).

Our method is usable for various physical objects for real shadows by analyzing depth data and color data. Figure 5 shows examples using flower arrangements with real plants to generate real shadows. Virtual shadows of petals appear from real shadows of flower arrangements, and virtual shadows of birds perch on real shadows of flower arrangements and a user.

4 Conclusion

In this paper, we proposed a method to interact with virtual shadows through real shadows by using two projectors. Our method realized various interactions with virtual shadows by real shadows, and it could be useful for entertainment, digital signage and so on.

Developing more various interaction and applications are future works.

Acknowledgements

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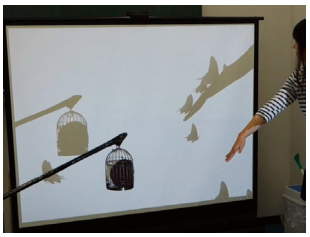
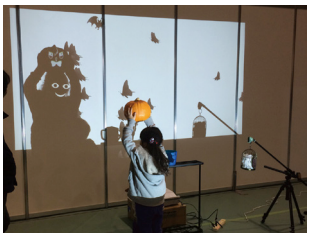


(a) Virtual shadows of butterflies perching on a user's shadow.

(b) Deforming real shadows by projecting virtual light sources inside the real shadows.



(c) A child surprised by eyes and mouths inside real shadows of her face and a pumpkin.

(d) A virtual shadow of a plant growing from a real shadow of a flowerpot.

Figure 4: *Interaction with virtual shadows and virtual light sources through real shadows of various physical objects.*

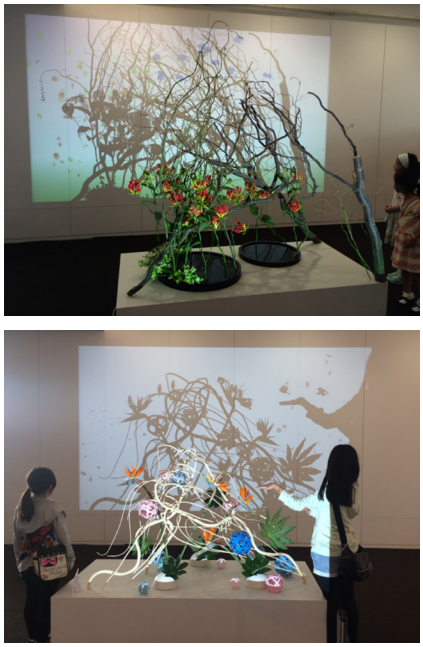


Figure 5: *Using flower arrangements with real plants to generate real shadows in the system.*