Restive Shadow: Animating Invisible Shadows for Expanding Shadowgraph Experience

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Abstract

This paper proposes a multiplexing invisible shadow system named "Restive Shadow." The proposed system uses infrared lights, each of which radiates a certain wavelength of infrared light, and an object to which two different types of IR filters are attached. Directing the light toward the object causes the object's shadow to appear; the shape of the object then appears to change according to the wavelength of the radiated infrared light. With this system, a user is expected to attain a different viewpoint on shadows.

CR Categories: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, augmented, and virtual realities

Keywords: shadow, multiplexing infrared light, entertainment system

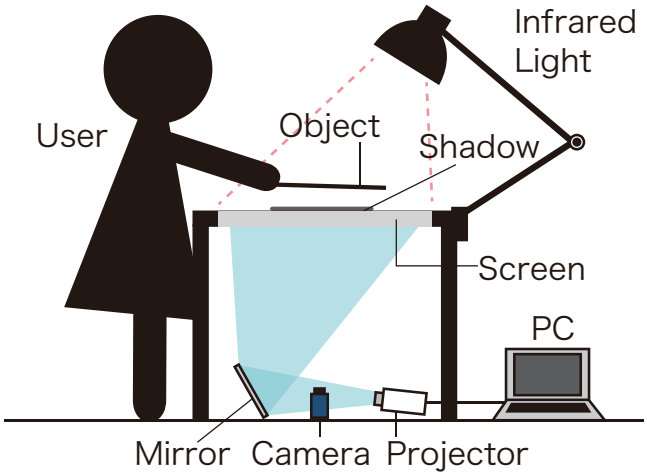

Figure 1: *System component*

1 Introduction

We recognize shadows unconsciously as part of everyday life. Many people recognize the common features of shadows (e.g., they are black or achromatic, have the same shape as the object, and follows the movement of the object or light source). However, we rarely think about their existence and simply accept their characteristics without further thought. Shadows have a close connection with entertainment: they are a familiar element in traditional performances such as shadow puppetry. In such performances, the properties of the shadows, such as mimicking the object's shape and movement, are exploited. However, shadows are formed by selectively blocking rays of light, and so while they reproduce the outline of the object, many visual characteristics (e.g., colors and lines) of the interior of the object are eliminated. We investigate the possibility of generating shadows with more details of the objects and independent movements. The purpose of this was to allow the user to become aware of a different viewpoint by intentionally subverting their normal expectations, specifically, the idea that a shadow is always simpler than the object that casts it and moves in the same way as the object.

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2 Related Works

Several studies have tried to extend shadows to applications in media arts. KAGE, which was developed by Chikamori *et al.*, generates object shadows with computer graphics and projects the shadows from the ceiling [Chikamori and Kunoh]. A user can play with the shadows, changing their shape and color, by touching conic objects fitted with touch sensors. The Textured Shadow/Movie-in-Shadow concept, developed by Minomo *et al.*, is a multi-projection system that changes the shadow of the user into a colorful shadow by using complementary colors [Minomo et al. 2006]. This system projects two different images from two different projectors onto the same region on the floor, and as the projected images are complementary colors, the illuminated part of the floor is white. When the user walks across the illuminated part of the floor, the projectors are turned off, and the complementary colors are removed from the user's shadow, which adds color to the user's shadow. Our proposed system is similar to that of Chikamori *et al.* in that it generates a shadow with a shape that is different from that of the object, but our system differs in regard to the multiplexing of the shadow by using different light wavelengths. Our system is also similar to that of Minomo *et al.* in that it increases the details of the shadow, but we capture the details of the object by using infrared (IR) light sources with multiple wavelengths.

3 System Components

Figure 1 shows an outline of the proposed system. The system consists of an IR light source, a camera that can capture IR light, a projector, a screen in the shape of a table, and various objects that create the shadows. When objects are placed on the table illuminated by the IR light, the system creates shadows that are invisible to the human eye. An SC-74 filter (FUJI FILM Corp.) is attached to the CCD camera (Watec Co., Ltd.; IR lens, Tamron Co., Ltd.) to transmit IR light with a wavelength of over 740 nm. DILAD screen

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Figure 2: *IR light source*

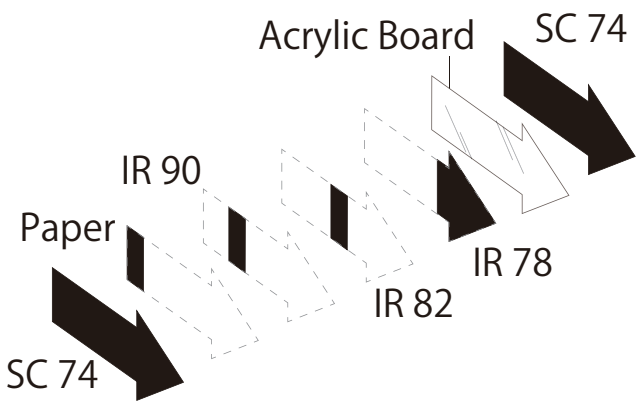

Figure 3: *Object*

(KIMOTO Co., Ltd.) is used as the screen material. It is suitable for back projection so that it enables the projection of invisible shadows by the IR light and the production of images by the projector. By placing the projector underneath the screen, interference of the image from the projector and the invisible shadow from the IR light is avoided. The IR light source (Figure 2) can be adjusted to produce one of four wavelengths: 770, 810, 870, and 940 nm.

4 Object

Figure 3 shows the structure of the object, the inside of which consists of four layers: a material that blocks the light (in this case, a piece of black drawing paper) and three IR filters (IR-90, IR-82, and IR-78). By making each layer a different shape, different shadows are produced when the object is illuminated with light beams of different wavelengths. Because the SC-74 filters are attached to both sides of the object, the user cannot see the internal structure.

5 Application

We created an application to demonstrate that the object shadow can appear to move. A user can interact with this application by holding objects above the table and generating shadows. The object is black and in the shape of an arrow. Figure 4 shows an application of this system. When the object is illuminated with 940 nm light, the shadow seen in Figure 4a is created. Light with wavelengths of 870, 810, and 770 nm generates the shadows shown in Figure 4b, 4c, and 4d, respectively. Thus, changing the wavelengths in this order creates an effect that causes the shadow of the object to appear as though it is moving.

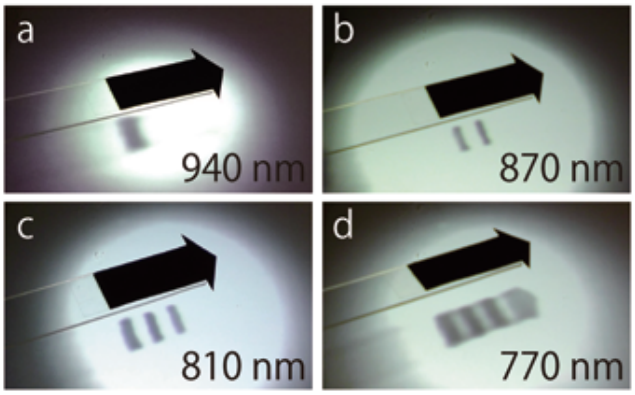

Figure 4: *Application*

6 Concluding Remarks

This paper proposed a system for generating moving shadows based on different IR light wavelengths. In a future work, we will attempt to expand the range of animation possibilities by combining the capture of the invisible object shadow shape with capturing markers [Sakaguchi et al. 2012]. We are in the process of developing novel animated shadows.

Acknowledgements

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References

CHIKAMORI, M., AND KUNOH, K. Kage. `http://www.plaplax.com/legacy/artwork/minim++/artwork/kage.htm`.

MINOMO, Y., KAKEHI, Y., IIDA, M., AND NAEMURA, T. 2006. Transforming your shadow into colorful visual media: Multiprojection of complementary colors. *ACM Computers in Entertainment 4*, 3.

SAKAGUCHI, S., TANAKA, T., SHINOKI, R., AND MATSUSHITA, M., 2012. Shadow++: A system for generating artificial shadows based on object movement. ACM SIGGRAPH 2012, Posters, Article 119, August.