

Shadow Awareness: Enhancing Theater Space Through the Mutual Projection of Images on a Connective Slit Screen

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ABSTRACT

This study discusses media technology that enables the continuous creation of performers' physical improvisation as inspired by the reflection of imagery evoked from the audience. To realize this, the authors have focused on "shadow media," which promote the continuous creation of imagery through "bodily awareness." The authors have developed a system that can project shadows of the performers in various ways, which are then transformed into various shapes and colors. The shadows are connected to the performers' feet and projected on a "passable" slit screen set up between the stage and the audience. As a result, the interactive and mutual creation of imagery by performers and audience can form an "empathetic" stage. To demonstrate its validity, the authors applied the system to a dance performance at Festival della Scienza in Genoa, Italy.

Introduction

We know from experience that stage performers can express a very evocative narrative by integrating reactions from the audience. Specifically, the audience's participation can inform and expand the continuity of a piece in cases where performers use physical improvisation. However, the relationship between performers and audience has not been fully studied in the field of media technology for interactive art and other uses. This paper describes the authors' work on media that allow performers and audience to interactively create a relationship through the use of body and image and the expression of both together during physical improvisation.

We have experience working on technologies that support physical improvisation. While improvising, performers must continuously create new images with their movements. We are interested in presenting medium incompleteness, because it is difficult for performers to stimulate the audience's imagination with ever-changing motion unless the media provide incomplete elements, which encourage the audience's imaginative participation. In other words, the "spatial blanks" (*yohaku*, a Japanese cultural concept of incompleteness) create a space for the audience's imagination within the motion. Good examples of these are those observed in *suiboku-ga* (Japanese ink paintings) and *Utsushi-e* (the Japanese version of a magic lantern) in Eastern culture [1], and shadow puppetry [2, 3], which exists in many cultures. We also considered the awareness of one's own body to be an important element in the process of continuous imagery generation. All this led us to consider the body's shadow. Shadows themselves are incomplete media which provide less information than general video media. Another important element of shadows (related to the concept of body awareness) is that they are always connected to bodies. A body always casts a shadow, yet we are often unaware of our own shadows. Shadows are incomplete embodied media.

In order to externalize the effects of the shadows, we devised a means of changing their forms and colors in various ways to allow continuous creation of the image and to raise awareness of

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Figure 1. Generation of bodily expression through the shadow media. © 2010 Yoshiyuki Miwa et al.

the performers' own bodies. Figure 1 shows various transformed shadow media we developed (we call this an "artificial shadow," which is transformed from a real shadow into "shadow media"). The interaction between the performers' own bodies and the shadow media causes them to move naturally in conjunction with soaring images. Also, when a gap between the shadow media and their own bodies emerges, the performers become aware of their own inner selves. And they can use this gap as the starting point for a new series of physical expressions. Through experiments conducted with expert dancers and pre-school children as part of their physical expression education, we found various effects of the shadow media [4, 5].

Previous studies have not been concerned with the relationship between performers and audience through shadow media. Therefore, in this study, we tried to help performers and audience to create a mutual relationship through both body and image. The method we used to achieve this was to place a screen that performers can pass through (Figure 2b) at the border between the stage and the audience, and to project the performers' shadow media on this screen. The audience encounters the performers' shadow media before encountering the actual performers, and the audience can create images in reaction to the performers' physical expressions while

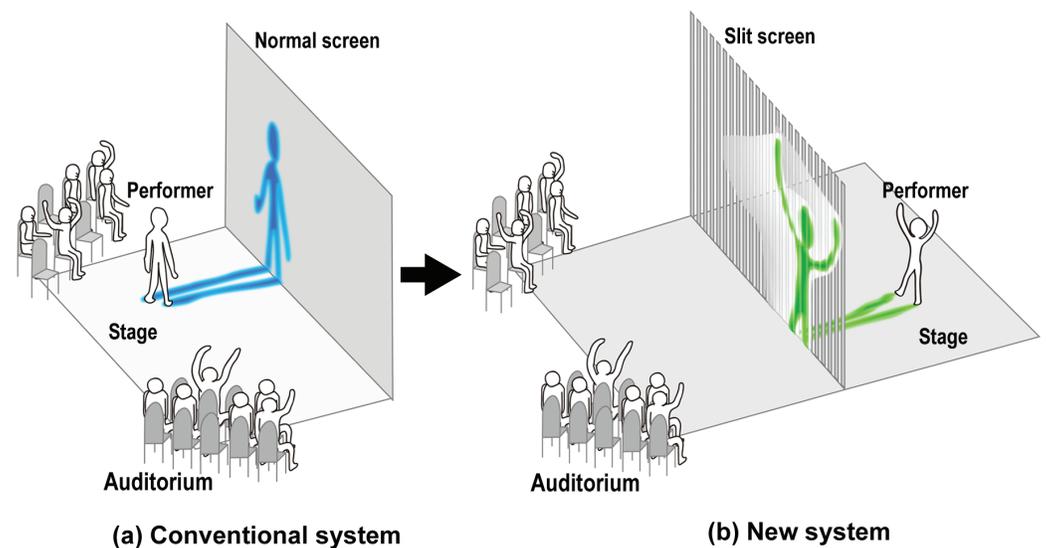


Figure 2. The method of projecting the shadow media. © 2011 Yoshiyuki Miwa et al.

appreciating the performers' shadow media. This shadow media projection offers two benefits to the performers as well. First, the performers can simultaneously see the audience and their shadow media projected on the screen; in other words, the performers can create physical expressions through the shadow media partially in response to the audience. This offers a solution to the conventional system shown in Figure 2a, in which performers cannot see the screen media and the audience simultaneously. The second benefit is that the performers can use the space in front of the audience as well as the space on the stage, which expands the performers' physical range of expression.

The following section describes the details of the system used to project the shadow media on the slit screen placed at the border between the stage and the audience. This system was exhibited at the Festival della Scienza in Genoa, Italy, and was used in our dance performances and co-creative physical expressions shown there. The results of those performances will also be discussed.

Slit Screen Connecting Audience and Performers

This study discusses technology that promotes an interactive relationship between performers and their audience; enables performers to create physical expressions while expanding their range of imagery through reference to their shadows and in reaction to the audience's existence and influence; and enables the audience to generate their own imagery through the shadow media while reacting to the performers' existence and influence. In order to achieve such results (Figure 2b), it is necessary for performers and audience to face each other so that each of them can share the shadow media. In order to maintain the inseparable relationship between a body and its shadow media, the projected shadow media is connected to the performers' feet so that it looks like their actual shadows. Projecting a silhouette image on the screen, disconnected from the body, would not be enough. One method by which the audience and the performers can share the shadow media while facing each other is to install a transmissive screen, which is made of a material, such as scrim or fabric, that allows the background of the stage to be seen, at the border between the stage and the audience. However, this method has a few problems: the projection on the screen shines through the screen itself and gets cast on the stage floor, and the shadow media that is intended to be projected only on the stage floor to show shadows connected to the performer's feet (for maintaining the inseparable relationship between body and shadow) appears on the screen. Therefore, we used a screen with vertical slits (Figure 2) to project the shadow media from the audience's side. This slit screen allows the projection of each individual image to be cast separately on the reed-textured screen (slit screen) and the floor (passing through the slits), which solves the problems mentioned above. This shadow media projection method also offers the following three advantages: (1) The audience can not only see the performers' projected shadow media, but also their bodies through the slit screen. (2) Performers and audience can move back and forth on each side of the stage through the physical gaps in the slit screen. This enables the inseparable integration between performers and audience. (3) Perceptual completion enables performers and audience to see the incomplete image on the slit screen as one cohesive shadow medium, although the image of the shadow media is fragmented (sliced) by the splits.

As shown in Figures 3a and 3b, thermal cameras and projectors placed on both sides of the slit screen to generate shadow media enable performers to pass through the slit screen and to create physical expressions through the shadow media generated on the auditorium and the stage floors. The audience can also participate in an ongoing performance (or enter the stage of physical expressions created by performers – "shadow media space") with their own shadows. This means that performers and audience can encounter and interact with each other through the use of shadow media. This system also makes it possible to project an image across the entire theater,

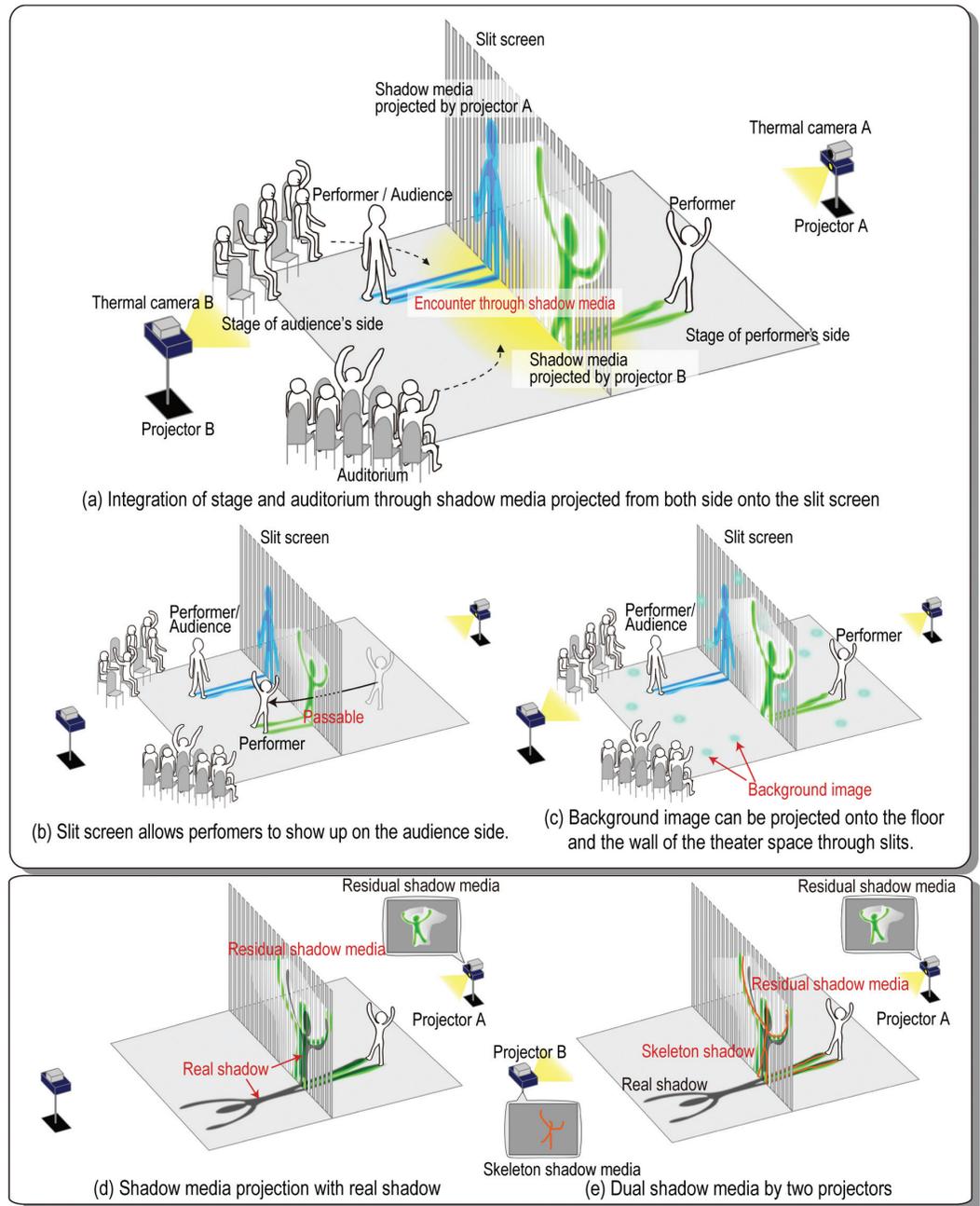


Figure 3. The new method for projecting shadow media images (concept). © 2011 Yoshiyuki Miwa et al.

including the walls and the ceilings above the stage and the auditorium enclosing the entire stage and auditorium in the image (Figure 3c). The slit screen can expand the stage to the entire theater. Finally, the stage and the auditorium can be integrated. Furthermore, as seen in Figure 3d, not only the shadow media, but also the performers' actual shadows can be simultaneously projected on the screen. Additionally, by projecting different shadow media from two projectors, the superimposed (dual) shadow media can be projected on the screen (Figure 3e). In comparison to the existing system (Figure 2a), our method expands the range of physical expressions through the use of shadow media. Thus, this system can be considered as an example of Eastern interactive media art. It projects shadow media on the slit screen which will bring about a spatial expansion and a sense of depth. In other words, this system provides *yohaku*, which is often seen in *suiboku-ga* Japanese ink paintings, enabling the audience and performers to create imagery together.

In general, interactive art that invites audience participation has focused on supporting direct interaction between an audience and a fixed artwork [6-10]. It has focused attention on the relationship between audience and artwork [11]. Myron Krueger, the famous researcher of interactive art, originated the focus on the relationship between performers and audience [12]. He argues that art's future direction is art created by the interaction between performers and audience. He proposes that performers interact with the audience by projecting silhouettes of both performers and audience in the shared visual environment of the video space he developed. However, in his concept, the space where performers and audience interact is virtual – shared, but only virtual – not a shared real environment. There are many technologies, such as those often used in traditional stage settings, that heighten performers' expressions by applying a special effect to either the stage space or the performer [13-16]; or that inseparably enhance the audience's rapport with the performers, such as waving penlights at concerts. In contrast, our new system, which enhances the relationship between performers and audience through their physical interactions in a real space, is the first attempt of its kind in the technological media field. This study attempts to apply technology to achieve interaction through shadow media that can stimulate the audience and performers to create images collaboratively. Shadow media are widely used in the human-interaction field to support interaction between humans. For example, there is the remote communication system (WSCS) [17] that enables the positioning of oneself and a remote partner in one's own physical location by exchanging the physical shadow of both participants between remote locations, and projecting the mutual shadows from each partici-

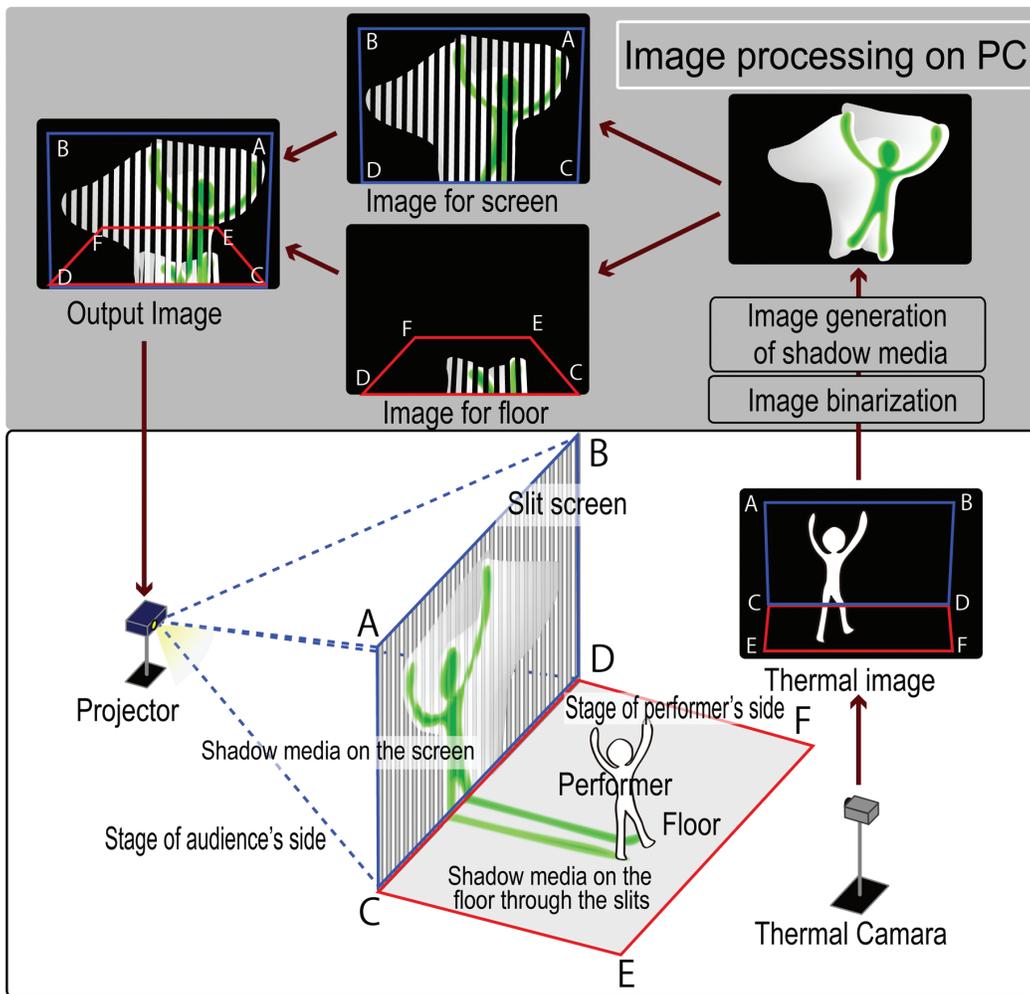


Figure 4. The method of projecting the shadow media on the slit screen. © 2011 Yoshiyuki Miwa et al.

part's location. The WSCS interaction system generates a situation where, in effect, the participants are actually talking to each other face-to-face. There are also several research programs, such as Passages (Bitton), that attempt to support remote communication by projecting the shadow silhouettes of remote participants on a screen [18]. The Palindrome dance company has conducted performances using performers' shadows to enhance their physical expression [19]; and Lozano-Hemmer has presented an installation in which a video image emerges from one's own shadow in an outdoor space [20], demonstrating that participants can play improvisationally with the help of their shadows. As a result, he successfully transformed a space that people pass through into a space where they meet and play. Among these projects in other arts, our research will be the first use of shadow media to position an audience on the stage and support the co-creation of the image, focusing on the relationship between performer and audience.

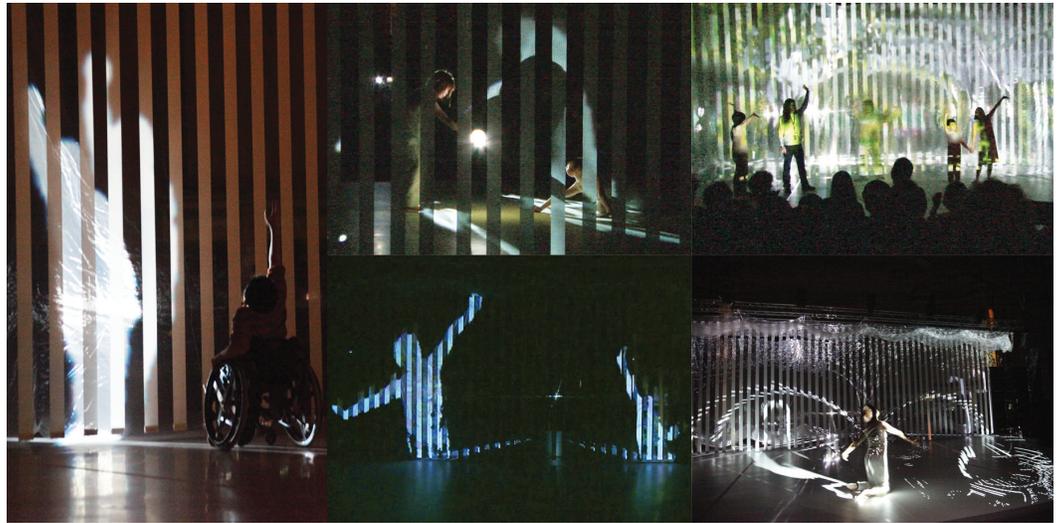


Figure 5. Scenes from *Dual 2010* at Festival della Scienza in Genoa. © 2010 Yoshiyuki Miwa et al.



Figure 6. Scenes from our public exhibit at Festival della Scienza in Genoa. © 2010 Yoshiyuki Miwa et al.



Figure 7. Participants going back and forth through the slit screen. © 2010 Yoshiyuki Miwa et al.

System for Generating and Projecting Shadow Media on Slit Screen

This section describes the system used for projecting the shadow media on the slit screen. As seen in Figure 3, this system can project shadow media on the slit screen in a variety of ways. The basic shadow media projection method projects the shadow media of a person standing in the performer's stage space. The system's structure is shown in Figure 4. First, the system creates the shadow media by acquiring a thermal image via a thermal camera located at the back of the stage, extracting the body's region, which has a different temperature from the surroundings, and processing this image with a computer. Assuming that the shadow media's light source is located in the position of the thermal camera, projecting this shadow media onto the performer's feet ensures a geometric consistency between the body shape and the shadow media. In this case, to avoid having the performer's actual shadows projected on the slit screen, the projector is situated on the side of the audience, and the shadow media stretching from the performer's feet must be projected onto the screen as well as the stage floor beyond the screen. The projected image must be divided into two sections: one projected onto the screen, and the other onto the stage floor. Each section is subjected to projective transformation for projecting on the screen or on the stage floor. In other words, the projected image is a composite of two images with alternate vertical stripes (Figure 4). This composite shadow is projected from the audience's side. The slit screen is made of polyester, which enables rear projection. Thus, this system can simultaneously project shadow media on the floor (to recreate a shadow stretching from the performer's feet) and on the slit screen. Although the shadow media system developed in the past had to be installed on the ceiling as a projecting source, the current projecting method does not require installation of projectors on the ceiling. This is quite beneficial because it halves the number of projectors required. Furthermore, as mentioned above, we can project the audience's shadow media by bilaterally and symmetrically arranging the new shadow media projection system with a central focus on the slit screen.

Exhibiting the System

This system was exhibited at the Festival della Scienza in Genoa (October 29 to November 7, 2010). This festival showcases communication through science, boasts participants of all ages and nationalities, and offers an opportunity for scientists and artists to create communities of practice. The Palazzo della Borsa, where the system was exhibited, was a circular space with a flat floor 25 meters in diameter. We set up the slit screen, which was four meters high and 10 meters wide, in the center of this space, making one part of the space a stage for the performers and the other a space for the audience. The opaque elements and the slits were, respectively, 10 and 12 centimeters wide. Each width was determined by conducting several experiments to see if audiences could see both shadow media projected on the slit screen and the performers behind the slit screen.

We produced a performance titled *Dual 2010*, which integrated shadow media and physical expression with the theme "Ancestors plant trees, descendants rest under the trees." We also conducted lectures on the system's technology. The system was open to the public, and we offered visitors an opportunity to experience this system freely.

The dance performance and the lectures on the technology, as well as several scenes from participatory exhibitions, can be seen in Figures 5 and 6. It was recognized that this system can project the shadow media of people on either the near or far side of the slit screen. Figures 5 and 6 also show that the shadow media are connected to the performers' feet. During the actual dance performance, we observed that the motion of children in the audience was elicited while performers showed physical expressions through the change of shadow media. And, at the end of the dance performance, the audience entered the shadow media stage space and created an

embracing stage with the performers. Comments from the audiences included remarks such as, “I could feel a sense of involvement with the scene expressed through the shadow media, which yielded an exchange of minds among the performers and the audience members, along with the storyline of the performance.” During our exhibition, we observed interactions between performers and audience across the slit screen. Children in particular often ran between the stage and the audience area, playing in an improvisational way through the shadow media (Figure 7).

We have been discussing our dance performance and exhibitions in Genoa so far. Their results indicate that the shadow media projected on the slit screen can work as a stage setting to create a scene where the performers and the audience can feel as if they were integrated as one large expression. Therefore, we think that this system has the potential to support empathic interactions between performers and audience. More than 2,500 people visited the shadow system exhibition at the Festival della Scienza in Genoa. It was extremely well received, and the *Dual 2010* performance was featured on the festival’s official web site and in the local media.

Conclusion

The present study discusses media technology that enables performers and audience to interactively create a mutual relationship through both body and image, and mutual expression through physical improvisation. Specifically, this study invents and implements the method of projecting shadow media through a transmissive slit screen placed at the border between the stage and the auditorium, transforming a body’s shadow form. We have developed the system in which performer and audience face each other, and in which the shadow media and the performers themselves can be seen simultaneously. We have also applied our newly invented method of projecting the shadow media onto the slit screen with the shadow media connected to the performers’ feet. In addition, projecting shadow media from both sides of the slit screen can accommodate the audience’s shadow media as well as the performers’, enabling the audience and the performers to share a common stage with the help of the projections on the screen. This system can also be used to project shadow media across the entire theater space. At the public exhibition of this system at Festival della Scienza in Genoa, which attracted considerable attention, performers and audience interacted to create a series of continuous narrative physical expressions, while the performers became aware of their own bodies and the effect of the audience. From these observations, we conclude that this system has potential as an interactive expressive media system that achieves co-creative physical expression.

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