Exploring the Potential of Mobile Projectors as a Body-Instrument for Performance

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ABSTRACT
Artists and scholars have been experimenting with interactive digital media to expand the aesthetic possibilities of their body movement and develop new performances. Based on our experience with implementing mobile projectors in public spaces, we propose three directions that take advantage of their capacity for performance conception and design. We also highlight the challenges that artists and HCI researchers may face when attempting to include mobile projectors in performances.

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Handheld projectors; Performance; Public Spaces; Interactive Media

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INTRODUCTION
Artists and researchers have been experimenting with interactive digital media to enhance the aesthetic richness of their body movement's expressiveness, scenography, and audience viewing experience. HCI research has been developing custom software with fixed projectors, computers, sensors, and cameras to enable artists to use their body movements as a means of interacting with or generating moving images, graphics, and text [6]. While such location-fixed technology setup allow artists to freely interact with digital media, they also constrain them to a predetermined location.

Alternatively, pico-projectors have been commercially available for some time now. These projectors are lightweight, battery-operated, and fit in the palm of user's hand. They can be used in any indoor or outdoor space for spontaneous media sharing [1] or blending digital media with real world [4]. By integrating sensors and mobile computers with a pico-projector, researchers have created interactions that allow users to influence digital images using gestures, movement, and position [3, 8]. Using mobile projectors can allow groups to cooperate and create sophisticated shared information spaces [2, 7]. Computer vision has been utilised with pico-projectors to dynamically recognise surfaces and objects in the physical world and project back on them [9]. Such sensor and mobile computer integrated pico-projectors (hereafter referred to as "mobile projectors") have the potential to enable artists to use their physical movement to interact with digital media and create projected augmented reality information spaces.

Limited research has been done to determine the unique attributes of mobile projectors and to conceive applications that may take advantage of these traits [4]. Thus, the lack of mobile projectors' uptake in performances could be attributed to a lack of understanding and ideas about how they could be employed in dance and theatre. We have employed mobile projectors during walks in urban and heritage settings. While conducting a series of walks, we discovered that employing portable projectors extended user's body in space, allowed users to directly express their intentionality through gestures and body movement, play with and modify their physical environment using projected augmented reality, and create a shared information space that encourages passers-by to watch (see Fig. 1) [5]. Based on our observations of how users used mobile projectors, we believe that mobile projectors can be very useful for performances. The use of mobile projectors in performances can reshape the relationship between the body, space, media, and the audience.

Mobile projectors can act as exciting body-instrument which have the potential to ignite new imaginations for conception of performances. In this pictorial, we propose three broad directions for the way mobile projectors can be used. Based on our previous experience with mobile projectors, we also discuss concerns that artists and HCI researchers will need to address when they try to employ mobile projectors for performances.

SETTING THE STAGE: INTERACTIVE MEDIA AND TECHNOLOGY IN PERFORMANCE

We identified three characteristics of performance to explore the possibilities of using a mobile projector. These are presented below.

Individual performer

- Enhance the aesthetic potential of the performer’s body movement.
- Enhance the communication potential of the performer’s body movement.

Scenography & space

- Expanding performative space beyond the fixed stage into the urban or natural surroundings
- Augmenting and transforming a static space into a dynamic environment
- Interacting with the environment

Collaborators

- Collaborate with other performers.
- Collaborate with the audience—engage spectators in the performance to enhance the overall experience.

PROJECT PROPOSAL

Based on the potential of sensor-computing-integrated mobile projectors we developed new project ideas. We propose three conceptual directions which highlight the potential uses for mobile projectors in performances. These would be suitable pilot studies for exploring their unique characteristics in the context of performance.

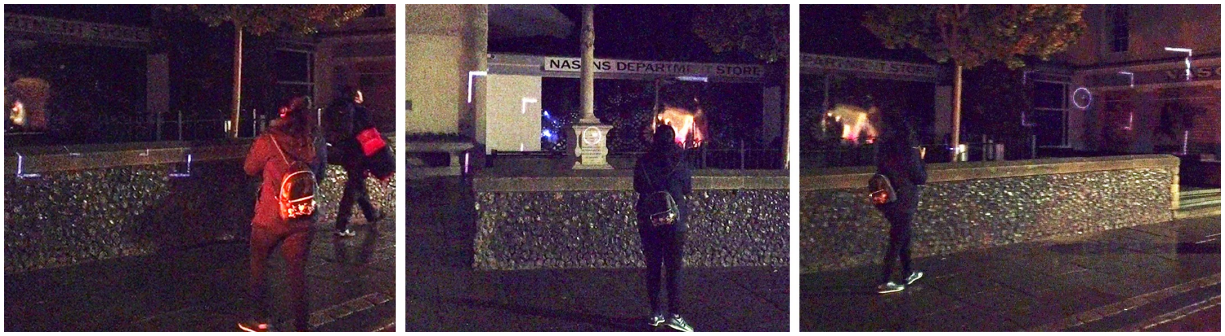


Figure 1(a)



Figure 1(b)



Figure 1(c)

Figure 1. (a) An example of projector guide user extending themselves in space and enacting playful exploration by scanning the physical environment (P18).

(b) Example of a projected display users (P9) projecting on the wall to share the heritage information with the passers-by

(c) The texture of physical surface intertwining with the digital media through projected augmented reality

EXTEND-ACTOR

During the heritage walks with mobile projectors, we discovered that the handheld mobile projector and its beam operated as extensions of the user's actions reconnecting their actions with space. The projected display screen's movement, size, and position in space acted as a direct and magnified portrayal of users' gestures, movements, and interaction with space.

Using a sensor-integrated mobile projector to create gesture-responsive media will directly interlink medial content and performers, extend performers movement in space, and enhance the expressive qualities of their gestures and movement leading to livelier performances [10]. Thus, to captilise on the affordances of the mobile projector we propose the *extend-actor* system. The system could be used to enable performer to project abstract visual elements (colour and form) that respond to their movement. For example, as seen in Fig. 2 the performer swings their hand from left to right, a visual element could bend in the opposite direction and change colour. Alternatively, the system could create distinct visual effects based on movement. For example, a performer's jump could result in a splash, or a hand wave could result in a wave-like image.

Thus, extend-actor system aims to accentuate the artist's movement and extends performer's expression. The use of the proposed concept is not restricted to what is described here. Changing the visual style and the interplay between performers' actions and visual alterations could open a world of possibilities.

Figure 2. Illustration depicting Extend-actor concept. The performer holds the projector in hand and as they move to perform, responsive media generates digital media depicting the flow of movement.



Figure 2

SCENE-GENERATOR

Space and scenography are important aspects of the performance. Traditional scenography adapts the space to the specific performance routine and narrative. With the advent of projection technology and interactive media, scenography has evolved into a responsive media that is as intertwined with the performing body as with space.

During the heritage walks, we observed that the act of projecting location-aware visual media onto the environment is a playful and performative intervention in space [1] as projecting enabled users to appropriate the space as their artistic canvas or arena. This inspires us to think of performance as an act of augmenting, transforming, and interacting with the urban or natural environment using a mobile projector. So, we propose the use of a mobile projector as a scene-generator. As the artist walks through a physical environment, the system's camera receives the video feed of the space as input. The software system manipulates the video feed and projects the manipulated visuals back into the real world. In addition to the video, this stream can also generate audio. Location-triggered content could also be added to the system (seen in fig. 3). Using such a system would enable artists to project space-responsive and location-based content back into the real world as they walk through the environment.

In the scene-generator proposal, we specifically focused on connecting the artist and the performance to the surrounding environment. The spectator's experience arises from watching the artist augmenting and transforming the perceptual and narrative qualities of the shared space that they are in.

Figure 3. Illustration depicting Scene-generator concept. The performer holds the projector in hand as they walk though the space (urban), they project on buildings, reappropriating the reality.



Figure 3

COLLAB-ACTOR

During the heritage walk, we observed that the use of mobile projectors made it convenient for users to share information with passers-by. Using the mobile projector, multiple artists and viewers could be collaborating and communicating with each other at the same time and in the same place.

This motivates us to propose the collab-actor system. A new mixed reality performance could be created where multiple artists could share a single networked mixed reality information space. They could simultaneously perform in the shared virtual space, each projecting their own portion of it back onto the real world as seen in fig. 4. In the real world, the projected visual information would create a meta mixed reality space collective created by multiple performers. Alternatively, artists could project digital artefacts such as costumes onto their co-artist to assist them in transforming into different characters during the performance. For example, one artist may transform another artist by projecting a tiger skin pattern on them. A group of artists could also project different visual elements into a space at the same time, creating a scenography for other artists to perform in.

Another possibility is for the audience to project in the performance space using the extend-actor or scene-generator to express themselves and become part of the ongoing performance. They could interact with the artist, influence the performance, and even become a part of the act. This could lead to inextricably linking the artist and the audience, as well as a blurring of the boundaries between the performance space and the audience space.

Figure 4. Illustration depicting Collab-actor concept. Multiple performers project interrelated augmented reality content (insects) in the space (forest) and performing together.



Figure 4

DISCUSSION

Based on our prior experience of deploying mobile projectors in urban environments, we discuss challenges and opportunities which artists and researchers may consider while working on any of the proposed direction. We discuss them below for consideration.

Leveraging the moving screen

One issue we observed during the heritage walks and anticipate affecting the use of mobile projectors while performing is that the display screen will be in constant motion, resulting in distorted and blurred images. While this may be seen as an issue, we encourage artists and researchers to consider this an opportunity. We propose that researchers to examine ways to maximise the expressive potential of artists' body movement using the projector's portable and mobile qualities. As indicated in our proposal for extend-actors, the movement of the mobile projector within and across space could frame a new relationship between body movement, digital media, and space. One of the ways to approach the design could be to use simple geometric shapes to reduce the complexity of the visuals. This would make them easy to follow even when the display is moving. However, artists and researchers who want to use mobile projectors still need to explore how to make visual media that is interesting to performers and spectators even when the screen moves all the time.

Capitalising the surroundings

The mobile projector allows the user to use any surface in the environment as a screen. During the heritage walk, we observed that the physical qualities of the surface affect the projected image's colour, brightness, and shape in three-dimensional space, all contributing to the experience of a blended mixed-reality space. Artists and researchers may perceive this effect of a physical surface on a digital image as visual interference. However, we encourage researchers to exploit this interplay of digital and physical images to expand the visual richness of digital media and conjure new creative expressions. We propose that artists and researchers explore ways to integrate the physical characteristics of the venue (nature, architecture, and objects in the surroundings) into the projected digital media, allowing artists to apply a variety of interaction strategies and transition between different physical settings and scenes. This could lead to a very interesting performance where the artist reveals new facets of their surroundings through active exploration. Artists and choreographers may also want to further explore the aesthetically effects and emergent audience experience of such intertwining of mobile performing body, the physical setting and the digital media output enabled by body-instrument like mobile projector.

Configuring the body-instrument relationship

Dancers, in particular, practise for years to obtain the correct flow, form, and dynamics. Adding an instrument to the body can alter their balance and the aesthetic quality of their movement. During the heritage tour, we saw people extend their bodies into space using the projector's beam. However, they highlighted that holding the mobile projector in their hands for extended periods of time would be tough. We expect a dancer's grip to be stressed if they have to hold the device while executing vigorous hand movements. Due to holding the gadget, they may be unable to make the finger movements prevalent in many dance forms. The device's placement on the body may also impact performance. An artist may hold or wear the device on their wrist to enhance hand movement and expression. The projector could also be positioned on the performer's back to enhance the surrounding space with scenographic elements. An artist could also employ numerous body-worn projectors simultaneously during performance. Further, there is also a need to explore and understand how these configurations affect dancers' perception of their interactions with the mobile projector and the interactive media. Thus, there is a need to explore how different body-instrument configurations affect the artist's body awareness, agency, control, movement, and connection to the surrounding space., while using mobile projector.

Designing mobile performance for audience experience

The interaction and choreographic unity of the artist's body movement, digital medium, and space enhances the audience's viewing experience. It's for this reason that choreography and media placement are planned with the audience's viewing angle in mind. However, while using the mobile projectors, the artist can walk across a vast urban or natural space, project anywhere in the space, and the audience can watch the performance from anywhere. As a result, using mobile projectors provides a challenging design problem, especially in terms of audience experience. A mobile performance can be difficult for the audience as it may appear chaotic and difficult to follow. However, the artist/s may walk the audience through the space like a tour guide and stop at key points to perform. Artists could test different performance styles, structures, and settings to see how audiences respond to mobile performances. Artists and researchers could also investigate how to give the audience more control over mobile performance. And how could they communicate and collaborate with the artist? using mobile projectors.

CONCLUSION

A lack of understanding of mobile projectors' capabilities may be a factor in their low adoption in the performing arts. We offer three directions for their use in performances. These suggestions are intended to motivate artists and HCI researchers to use mobile projectors to conceptualise innovative outdoor performances in urban or natural settings, thereby giving the performance a new dimension. Lastly, we discuss the challenges and opportunities that may arise when considering the application of mobile projectors for mobile performances.

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