Performative Surface: Double Sided Interaction

Hugues Bruyère
Concordia University
1455 de Maisonneuve Blvd. W.
Montreal, QC, H3G 1M8

hugues@smallfly.com

Thierry Giles
Concordia University
1455 de Maisonneuve Blvd. W.
Montreal, QC, H3G 1M8

thierry@thierrygiles.net

ABSTRACT
This paper introduces a framework which we label "performative surface" focusing on the performative relations that occur between co-located individuals mediated by an interface. The goal of this interface is to emphasize the intensity of interaction by way of a two side responsive surface. The paper describes both the conceptual and technological parts of this framework, compares it to existing applications, and presents examples from two produced installation prototypes.

Categories and Subject Descriptors
J.5 [**Computer Application**]: Arts and Humanities; H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities

General Terms
Performance, Design, Human factors

Keywords
Performative surface, haptic interface, co-presence, HCI, augmented reality, interactivity, computer vision

1. INTRODUCTION

The "performative surface" (double side interactive surface) is a newly developed tactile user interface designed to enable and to enhance corporeal co-presence [10].

While the majority of touch interfaces involve contact of the hands with only one side of an unyielding surface, this research focuses on creating interactive systems that capture whole body input through both sides of a haptic medium; a surface that is sometimes malleable, sometimes bendable, and sometimes hard. The physical characteristics of double sided and haptic medium play a critical role in the resulting experience of embodied interaction and co-present performance [3].

In the case of mediated inter communication, more often than not, the interlocutors are geographically spread. In contrast, the notion of the double sided interactive surface, in which multiple co-located participants are invited to interact on both sides of the membrane, permit us to rework our assumptions and perceptions about interaction in general. This framework of tactile interface offers simultaneous layers of communication-performance, in which, the participants use their bodies as the active element of the interface. By expanding and amplifying interaction via the implication of co-present bodies (see Figure 1), we produce an interface that engages people on an intellectual, emotional, and physical level.

Figure 1. Co-present performers.

2. RELATED WORKS

Paul Sermon's *Telematic Dreaming* [8], acknowledged as one of the most significant telematic works, creates an environment of telematically linked beds enabling the participants to be virtually together. Despite the fact that the bodies of the users are the main elements of the communication, the body of the other party (at the other end of the video link) is ghostlike, without substance. By allowing users that are not geographically dispersed to interact through a medium that is both physical and digital, the double sided interaction interface enables co-present embodied interaction that was previously inhibited by social barriers.

The *CityWall* [9] project, located in Helsinki – Finland, is a large multi-touch display. Although the conceptual and technical approaches are quite similar, our multi-touch system focuses on the co-performance taking place between participants either than focusing on the co-collaboration. By paying attention to the tactile quality of the surface and allowing the participants to act from both sides of the systems we, again, push the interaction to reach the range of the naked sense perceptions of the participants (see Figure 2).

Figure 2. Embodied interaction.

3. TECHNICAL FRAMEWORK AND SYSTEM DESIGN

The "performative surface" is based on a simple, inexpensive, and scalable setup-technique that enables a range of movement from multi-touch to full body sensing on a double sided interactive surface. All uses of this framework consist of human, computational and physical-architectural elements. The computational part of the system can be subdivided into two components, capture and visualization, both built in Processing/Java.

The video capture system utilizes a consumer-grade security analog video camera which feeds into a custom video signal processing module to extract the performers' body parts in contact with or in front of the "performative surface". The physical framework makes use of the silhouetting method based on the optical blocking (or eclipsing) of ambient infrared illumination (produced by standard rope lights in our current applications). In doing so, there is not a need for treatment or implementation of heavy computer vision techniques in order to extract the "performer's" body (see Figure 3).

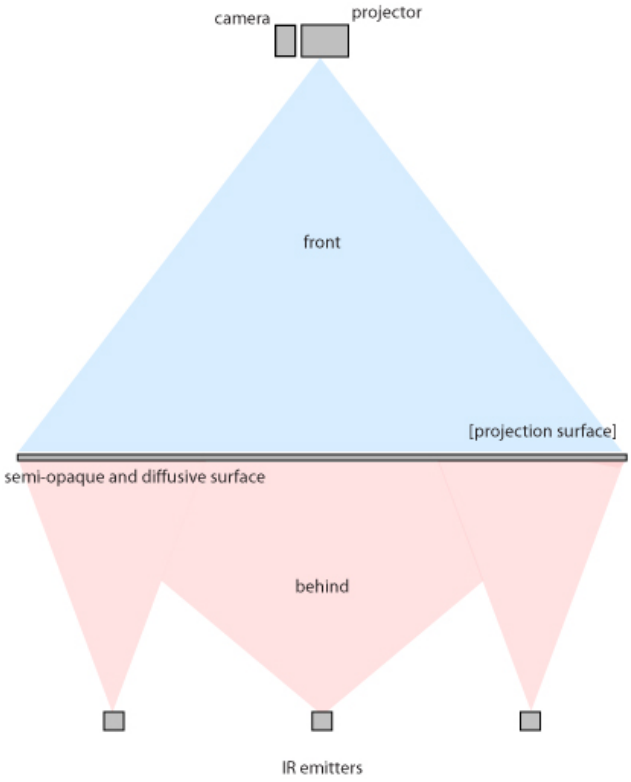

Figure 3. Physical framework.

Our physical framework could be seen as a merger of the two infrared designs used by the following systems: HoloWall [7] and Virtual PAT [4]. By using non-visible light, it permits simultaneous video projection and surface sensing. The double sided surface sensing aspect of the "performative surface" is permitted by using a screen made of a semi-opaque and diffusive material. From the camera view, the screen resolves only the body parts that are in contact with the surface of the persons 'behind' the surface [7] (see Figure 4), and the entire body silhouette of the persons in 'front of' the surface [4].

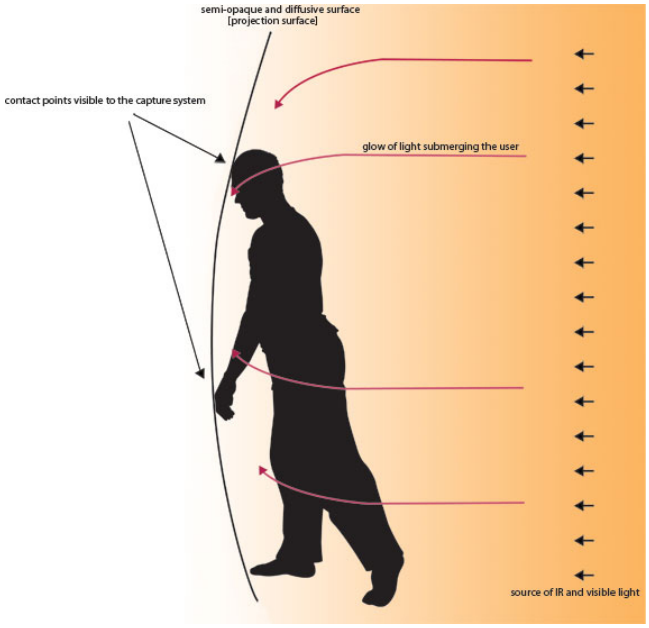

Figure 4. The physical setup removes the need for standard image treatment.

It is important here to specify that what drives our technical research and system design is our desire to keep the "performative surface" framework open and flexible. The system is not dependent on one specific type of technology, such as Jefferson Han's multi-touch interface [5] but rather on the interaction between an openly specified set of components. By not being bound to strict technical requirements, this framework is able to be used in different forms and locations, and as a result, enables the facilitation of a wider range of interaction.

4. CONCEPTUAL FRAMEWORK

Our research aims to explore the concept of the double sided interactive surface to push the use of a basic, soft and tactile surface, to augment individuals' awareness of the other person(s) and physical space. By removing the barrier to personal interactions and exploring the encounter of bodies, digital artifacts and physical material, we want to augment the "inter performances" between people, system and surrounding space.

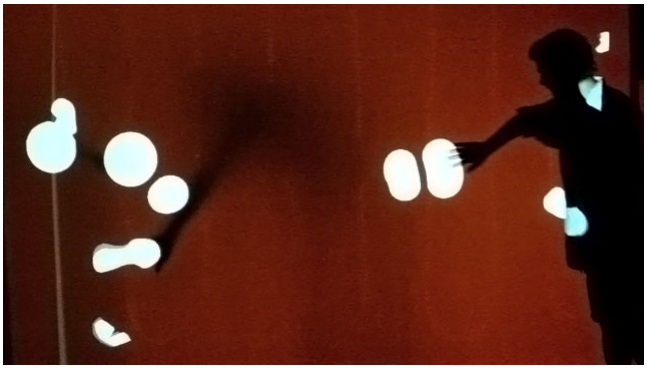

Figure5. Human-system interaction.

We explore interfaces that are not consciously perceived and consequently, push the participants to find themselves as an integral part of this interactive environmental system. Our approach is not to leave total "control" to the participants, but rather to create an equilibrium of power between the users and the surrounding space; to become conscious of ourselves as bodies, immersed in a dynamic relation with space, technology and others [8].

The "performative surface" framework helps us produce installations that makes possible fully embodied communication between people and system. For example, the use of a double sided flexible and malleable surface facilitates the creation, by the users themselves, of tactile stimulus (see Figure 6). The sense of touch, an important sense in many tasks, has been noticeably absent in interactive installation because there is no easy way to dynamically create tactile stimulus. Our approach attempts to be different from other "gesture-based"/multi touch systems by paying attention to the tactile quality of the surface and to the haptic interaction that takes place between multiple participants.

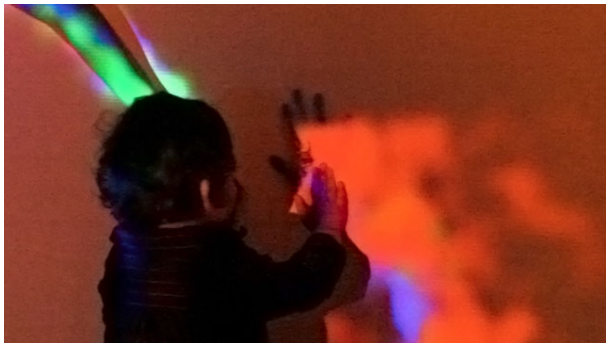

Figure6. Haptic interaction.

The "performative surface" framework is deeply informed by the notion of performance; such as several pioneering works of Myron Krueger [6] (Metaplay and Videoplace). The applications using the framework focus on the performative relations that occur between co-present individuals mediated by the interface.

5. APPLICATIONS

Given the conceptual and technical frameworks that have been set out, we developed several prototype applications in order to test the results. These applications (*Soft n' Silky* and *collective Shadow*) invite the users to perform, to play, and to engage in a dialogue with the system and the co-present participants as well as the surrounding space. The results were two interactive installations that are both sensorily attractive and require both mind and body engagement.

The first example, *Soft n' Silky* [1] uses a 10'x 8' 300-thread-count fine cotton sheet, which we stretch on a 10'x 8'x 3' custom made frame. This sheet is back-lit by standard rope lights. Since the cotton sheet is semi-opaque and diffusive, the performers' shapes (from hand to full body) are invisible to the camera. When a performer moves close enough or comes into physical contact with the screen, she/he creates an invisible shadow due to infrared

light frequencies and thus, becomes visible to the camera and to the system. Using simple image processing techniques, such as thresholding, the system produces images which show the shapes that are in contact with the interface and are blank everywhere else.

For Soft n' Silky, the choice of material for the wall interface aims to highlight the sensual and intimate experience of the participants. Furthermore, the elasticity of the membrane gives a 3D aspect to the interface surface as it can be manipulated in more interesting ways than a hard 2D surface. During our presentations of this installation, we begin to see concrete evidence of our endeavor to create a system that is both intuitive and innate. For example, we received a poignant piece of feedback given by a pregnant woman during one of our presentations. Upon interacting with other participants using the 'sensual' surface, she felt her experience was, in some way, similar to her experience of being pregnant and the sensation-interaction she was having with her baby.

collectiveShadow [2] uses this similar setup except for the tactile screen, which in this case, is constructed out of three 4'x8' sheets of Coroplast placed side by side to form the same 10'x 8' "performative surface." The co-performers see an abstract representation of themselves on the interface. These representations follow their movements like a delayed mirror-image or shadow. The interdependence of persons within the environment establishes a conscious and unconscious relation between one another by the means of diffused shadows (see Figure 7). The defamilarized social interaction collectiveShadows generates creates a meaningful distinction between collective and individual shadows. This is an attempt to see ourselves from the outside, to stand side by side with others and to allow the emergence of hidden selves from out of the collective image.

Figure 7. Performance mediated by the double side surface.

6. CONCLUSION AND FUTURE WORK

We believe that the concepts of "performative surface" and double sided interactive surface have potential as a conceptual framework for the exploration of new kinds of public inter-performances.

Soft n' Silky and *collectiveShadow* are the first, of a series of interactive multi-pieces that have explored these concepts. Future technical work will include improvement of the computational part of the system, for example: to determine whether two contacts were produced from two distinct participants; to use better vision techniques that could allow occlusions from multiple people and; to extend the framework by incorporating other types of sensors, such as microphones. We also aim to explore new types of architectural constructions, such as inflatable structures and also to look at new physical setups that would reduce volume and increased portability.

7. ACKNOWLEDGMENTS

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